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TABLE OF CONTENTS.

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THE AMERICAN

METEOROLOGICAL JOURNAL.

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PAPERS FROM THE PHYSICAL GEOGRAPHY LABORATORY OF HARVARD COLLEGE.

No. 10. — A NEW SERIES OF ISANOMALOUS TEMPERATURE CHARTS, BASED ON BUCHAN'S ISOTHERMAL CHARTS.

SAMUEL F. BATCHELDER.

THE distribution of temperature over the surface of the globe affords one of the most curious and important fields of meteorologic research. The elementary geographies teach that the distribution can be classified into five zones, bounded by certain latitude circles symmetrically placed on either side of the equator. A true chart of the temperature zones of the globe, however, shows the inaccuracy of such a statement. Examine, for example, the chart of Dr. Alexander Supan ;* the hard and fast "tropics" and "circles" have scarcely anything to do with temperature boundaries ; they are merely limits of certain astronomical positions of the sun. In the North Temperate Zone of the school text-books, that region vaguely suggesting a pleasant even temperature, there exists at one point one of the severest Arctic temperatures known, and at another, on the same latitude, an almost tropical heat. In short, the variations of temperature in any zone, or in any ring of a zone, play havoc with the old-fashioned orderly theories, and become of the greatest practical importance. The discussion of these variations is the object of the present paper.

* *Die Temperaturzonen der Erde.* Petermann's Mittheilungen, XXV., 349 (1879.)

The orderly theories long prevailed. The scientists of the Old World, misled by the exceptional regularity of European temperature distribution, assumed that the heat of the globe was regulated by the simple distribution of the sun's rays, thus being greatest at the geographical equator and steadily decreasing on every successive latitude to the poles, where the maximum obliquity of the rays and their total absence during six months of the year produced the greatest terrestrial cold. Some notice, to be sure, was taken of modifying causes: Halley noted the effect of "high Mountains, whose height exceedingly chills the Air brought by the Winds over them; and of the nature of the Soyle, which variously retains the Heat, particularly the Sandy,"* and Cotte put the cart neatly before the horse by announcing that the temperature of a place depends on its climate! In the main, however, the efforts of the early scientists — Mairan, Halley, Mayer, Kirwan — were directed to the determination of the pure action of the sun's rays, or solar climate.† But the extraordinary bleakness of the climate of the northeastern portion of the New World put a severe check on the development of the nice temperature theories of the mathematicians. To find that the Hudson River, in the same latitude as Rome, was frozen for a fifth of the year, and that the January temperature of Montreal, in the latitude of Milan, was that of the same month at the hospice of St. Bernard, suggested a flaw in the rule that the temperature of each latitude was constant throughout, and bore fixed proportions to the temperatures of the adjacent parallels, and drove Halley to the ingenious supposition that the North Pole had once been near Hudson's Bay, but that the "*choc*" of a comet's collision with the earth had shifted its axis to the present position, leaving the region of the former Pole so completely chilled that it had never fully recovered from its ancient iciness.‡

Such conjectures showed that it had begun to be understood that something beside solar climate was at work to produce these variations of temperature on the same latitude. One of

* Phil. Trans. XVII., 878 (Sept. 1693).

† That such speculations are not yet done we have abundant proof. Two recent formulas for Solar Climate are in Table VII.

‡ Phil. Trans., Vol. VI. (Abridgment), Pt. II., p. 1 (1694).

the earliest notices of variations* from the latitude normals was taken by Le Prince Cotte in 1791, who follows a table of temperatures at various points with these remarks: —

"Il resulte de la Table précédente: —

1°. Que la chaleur diminue successivement à mesure qu'on s'éloigne de l'équateur vers le pôle.

2°. Que les progrès de cette diminution éprouvent de très-grandes anomalies dans certaines latitudes, anomalies qu'il est impossible de soumettre au calcul, parce qu'elles sont occasionées, soit par la nature du climat ; ainssi une parti de l'Amerique septentrionale qui est à la même latitude que l'Italie et nos départements méridionaux de la France, est cependant beaucoup plus froide que ces pays où la chaleur moyenne s'élève beaucoup plus haut ; soit par le local ; ainssi la température d'une montagne est plus froide que celle d'une plaine. Un pays humide, couvert de bois et non encore défriché, est plus froide que celui qui est situé dans un terrein sec, découvert et bien cultivé: le froid est moins vif dans la voisinage de la mer, que dans les endroits situés au milieu des terres.

3°. Qu'il est donc impossible d'établir une comparaison exacte entre les degrés de chaleur que donne la théorie fondée sur la différence des latitudes, et ceux qui resultent de l'observation immédiate."†

The variations that impressed Cotte were apparently those

* Kirwan, after an elaborate discussion of the solar climate, plaintively adds that "many local causes oppose the regularity of the relations thus established." — *Est. Temp. diff. Lat.*, 1787.

† Obs. Phys. XXXIX. 42, Paris, 1791.

TRANSLATION. — From the above table it follows: —

1st. That the heat regularly decreases in proportion as the distance from the Equator towards the Polė increases.

2d. That the regularity of this decrease suffers great anomalies in some latitudes — anomalies which it is impossible to formulate, because they result either from the character of the climate, — as in a part of North America in the same latitude as Italy and our southern departments of France, yet much colder than these countries (where the mean temperature rises much higher), — or from the situation; the temperature of a mountain, for instance, is colder than that of a plain. A wet country covered with woods and not yet cleared is colder than lands lying in a dry, woodless, and well-cultivated region. The cold is less intense in the neighborhood of the sea than in tracts lying in the middle of the continents.

3d. That it is therefore impossible to institute a rigid comparison between the degrees of heat given by the theory based upon difference of latitudes and those which are the result of direct observation.

sometimes observed on a *meridian*, and the causes he names are inadequate enough ; his remarks, however, are of historic interest. Compare them with the summary of the same subject published ninety-two years later by Dr. Julius Hann :—

"Durch den Umstand, dass ein Parallelkreis teils über Land, teils über Wasser verläuft, entstehen klimatische Unterschiede zwischen West und Ost, oder Verschiedenheiten des Klimas nach den Meridianen, welche im solaren Klima nicht vorhanden wären. Neben der ungleichen Erwärmung und Erkaltung von Wasser und Land werden ausserdem durch das Vorhandensein des Landes gewisse konstante Luft- und Meeresströmungen erzeugt, welche ebenfalls eine Verschiedenheit des Klimas unter verschiedenen Meridianen desselben Parallels bedingen."*

The word *anomaly*, first used in connection with temperature by Cotte, was taken up by Dove in his "Distribution of Heat over the Surface of the Globe." This famous work, published in 1852, contained the first Charts of Isanomalous Temperatures (Thermische Isanomalen); they were dedicated to Humboldt, the inventor of isotherms. Although Dove's material was collected from somewhat more than a thousand stations, the points of observation were so irregularly grouped that for practical purposes their number was considerably less. Of the interior of North America, for example, he was unable to give any account for several months of the year. His work, in short, although of great value, was in a new field, and necessarily rather tentative than exact. In spite of its deficiencies, however, it was for many years the standard.

In 1878 a valuable addition was made to the subject of isanomals by the publication of an *Étude sur la Distribution relative à la Surface du Globe, des Températures et des Pressions moyennes pendant les Mois de Janvier et Juillet, avec 2 Cartes d'Isobars et 2 d'Isanomales*,"† by Léon Teisserenc de Bort. In these

* Handbuch der Klimatologie, 1883, p. 79.

TRANSLATION.—Owing to the fact that a circle of latitude passes partly over land and partly over water, there arise climatic differences between West and East, or variations of the climate according to the longitudes, that in the solar climate would not exist. Following the dissimilar warming and cooling of water and land there are, moreover, set up, owing to the presence of the land, certain constant air and sea currents which also make possible a difference of climate on different meridians of the same parallel.

† Annales du Bureau Central de la Météorologie, Paris, 1879, Pt. IV.

charts the advance over Dove's work was especially noteworthy in the increased deformation of the lines of equal departure, or isanomals. Dove's had been vague and gentle in curvature, but de Bort's were full of sharp and sudden bends, small isolated areas "too cold" or "too hot," and similar evidences of advance in amount and accuracy of material and care in treatment. The normal temperatures of the parallels of the northern hemisphere De Bort took from Dove's tables, the southern, from the isothermal charts of Hann.* The temperatures of his separate stations he compiled from seven hundred continental positions, besides islands, the records of ships' logs, etc.

The recent publication of Dr. Alexander Buchan's isothermal charts, based on the observations of the "Challenger" Expedition,† has afforded, for the determination of isanomalies, a new set of materials, on which the present paper is based. The period of the observations is the fifteen years, 1870–1885. The temperature readings, preferably the daily maximum and minimum, were carefully corrected for personal equation of observer, faulty thermometer,‡ irregular observation hour,§ height (at the rate of 1° F. for two hundred and seventy feet), differentiation for stations at which observations were not made for the whole of the fifteen years, etc. The total number of stations used in constructing the isotherms was somewhat over sixteen hundred. The resulting curves were plotted for each month of the year, on two series of charts, — one on an equatorial projection, the other on a north polar. The former series was taken as the basis of investigation, although it is to be noted that the two sets do not agree exactly, and differences of 2° and 3° are common.

Buchan's charts for January and July were selected as showing respectively the coldest and the hottest periods on the main continental masses of the globe; January being the month in which the cold on the northern hemisphere,— then turned away from the sun, — though theoretically greatest on Dec. 21, the

* Zeitschr. für Met., Band VII.

† Voyage of H. M. S. "Challenger." Physics and Chemistry, Vol. II ("Manuscript received during 1888–89.")

‡ Especially Portland, Australia.

§ Especially Hobart Town. "These faulty mean temperatures at Portland and Hobart Town for long thrust the isothermals of this part of the globe seriously out of their proper positions." Challenger Report, p. 44.

shortest day, reaches its actual maximum, and July showing the similar culmination of summer heat. In addition to these extremes, the chart for the year, or the mean of all the months, was taken to show the general average of isanomalies. All three of these charts were subjected to the same operations, as follows: —

The normal temperature of each tenth degree of latitude, from 80° N. to 50° S., was determined by averaging the observed temperatures at thirty-six equidistant points or stations on the circle, — that is, at every tenth meridian. The temperatures at these thirty-six points were determined, if an isotherm did not happen to fall directly over the point, by interpolation between the nearest isotherms. Although one authority * considers that "It is by no means an easy matter to deduce the mean temperature of a given parallel correctly from an isothermal chart,"† yet as Buchan constructed his isotherms at intervals of 5° F., interpolation was usually simple and direct, and the limit of error rarely rose above one degree. The most unsatisfactory cases of interpolation were those where the station occurred in a loop of an isotherm near a very rapid gradient (or close succession of isotherms) as in July, 130° W. 50° N. Still, even here, 1° F. seems usually the limit of error. A peculiar case occurs in January over the northern Amazon basin; as the observer moves northward over South America he finds the temperature fall from the central part until above the equator, where occurs an isolated area of +85° over the Isthmus of Panama. The neighborhood of this area is very difficult to interpolate for; to the north the nearest isotherm is that of 75°, a ten-degree skip, to the east and west are no neighboring isotherms, and far away to the south is the isotherm of 80° on a *falling* gradient. In the case of the parallel of 80° N. on the Annual Chart, too, the limit of error between 100° W. and 130° W. may rise as high as 4° F. On the equator, owing to the slight gradient, the general limit of error is about 2° F.

The parallel of 80° north latitude is only partially covered by

* Forbes, "Inquiries about Terrestrial Temperature," Edin. Trans. (1859) Vol. XXII., 79.

† Humboldt is even more severe. "To demand what is the mean temperature, or what is the magnetic inclination under a particular degree of latitude is to propose problems equally indeterminate." Edin. Phil. Jour. III., 11 (1817).

Buchan's isotherms in the charts of January and July. As, for the sake of completeness, the departures for this circle were desirable, two methods were used to obtain its readings. By the first, or Dove's method, Buchan's polar projection of the Northern Hemisphere was divided into four equilateral triangles, of which the opposite pairs differed as much as possible in temperature-distribution. In each triangle the mean of every tenth parallel's temperature up to 70° N. was determined, as before, from stations 10° apart, and the results for each opposite pair of triangles were plotted as ordinates of a curve. The middle portions of this curve, viz., from 70° to the pole and down to 70° in the opposite triangle, were, of course, missing, but by superimposing the curves of both pairs of triangles, and remembering that one point, the pole, was common to both curves, the missing portions of both were easily sketched in, giving four graphical

1. JANUARY LATITUDE TEMPERATURES IN OPPOSITE SPHERICAL TRIANGLES.

	LONGITUDE.	Equa.	N. 10	20	30	40	50	60	70
Triangle of Lon. 0°, Equa., & Lon. 90° W.	Greenwich 0	78	83	73	62	49	42	+40	+24
	W. 10	80	81	72	62	55	48	+41	+20
	20	81	77	71	64	59	49	+38	+13
	30	82	78	73	65	58	46	+32	+ 3
	40	81	77	73	66	55	39	+23	— 4
	50	80	78	74	66	50	24	+18	0
	60	82	77	75	66	46	6	— 3	— 7
	70	83	84	76	65	36	0	—18	—22
	80	79	85	75	60	35	0	—25	—27
	90	77	83	69	53	29	2	—27	—29
	Sum	803	803	731	623	472	256	119	—25
	Mean	80.3	80.3	73.1	62.3	47.2	25.6	11.9	—2.5
	Decrease..........	-	0	7.2	10.8	15.1	21.6	13.7	14.4
Triangle of Lon. 90° E., Equa., & Lon. 180°.	E. 90	82	79	70	56	30	+ 2	—10	—31
	100	81	78	70	54	29	— 3	—17	—38
	110	80	78	64	47	24	— 7	—22	—43
	120	80	78	68	42	15	— 8	—29	—47
	130	80	77	72	45	20	—13	—27	—45
	140	80	77	72	50	29	— 5	—18	—44
	150	79	76	72	55	35	+12	—10	—40
	160	78	76	71	57	39	+25	— 4	—35
	170	78	76	71	61	46	+32	+ 6	—30
	180	78	75	71	63	52	+37	+25	—23
	Sum...............	796	770	771	530	319	72	—106	—376
	Mean....	79.6	77.0	77.1	53.0	31.9	7.2	—10.6	—37.6
	Decrease..........	-	2.6	—0.1	24.1	21.1	24.7	17.8	27.0

2. JANUARY LATITUDE TEMPERATURES IN OPPOSITE SPHERICAL TRIANGLES.

	LONGITUDE.	Equa.	N. 10	20	30	40	50	60	70
Triangle of Lon. 0°, Equa., & Lon. 90° E.	Greenwich 0	78	83	73	62	49	42	+40	+24
	E. 10	80	85	71	62	51	34	+28	+30
	20	86	85	71	60	51	28	+24	+27
	30	88	85	75	60	44	22	+18	+20
	40	85	82	76	61	48	18	+12	+15
	50	81	79	70	57	40	11	+ 6	+ 6
	60	80	77	74	62	37	4	+ 2	− 5
	70	81	78	72	60	40	3	− 7	−17
	80	82	79	73	59	31	4	− 9	−24
	90	82	79	70	56	30	2	−10	−31
	Sum	823	812	725	599	421	168	104	45
	Mean.	82.3	81.2	72.5	59.9	42.1	16.8	10.4	4.5
	Decrease.	-	1.1	8.7	12.6	17.8	25.3	6.4	5.9
Triangle of Lon. 90° W., Equa., & Lon. 180°.	W. 90	77	83	69	53	29	+ 2	−27	−29
	100	78	80	76	55	33	− 3	−22	−35
	110	79	78	70	62	49	+10	−15	−35
	120	79	76	70	60	47	+25	−12	−25
	130	79	75	70	63	56	+44	0	−25
	140	78	75	70	64	58	+47	+23	−24
	150	78	74	70	65	58	+45	+25	−23
	160	78	74	70	65	57	+42	+10	−19
	170	78	74	71	64	46	+39	+25	−18
	180	78	75	71	63	52	+37	+25	−23
	Sum	782	764	707	614	485	288	32	−256
	Mean.	78.2	76.4	70.7	61.4	48.5	28.8	3.2	−25.6
	Decrease........	-	1.8	5.7	9.3	12.9	19.7	25.6	28.8

3. JULY LATITUDE TEMPERATURES IN OPPOSITE SPHERICAL TRIANGLES.

	LONGITUDE.	Equa.	N. 10	20	30	40	50	60	70
Triangle, Lon. 30° W., Equa., & Lon. 120° W.	W. 30	78	81	78	75	71	58	51	41
	40	80	81	79	76	71	55	47	41
	50	81	82	80	77	70	55	47	42
	60	80	82	81	79	70	56	45	41
	70	79	81	82	80	71	62	45	40
	80	76	81	83	81	77	63	47	39
	90	74	79	84	83	80	66	53	40
	100	75	78	90	91	85	72	57	40
	110	76	78	78	90	95	75	62	39
	120	77	78	76	69	80	70	66	40
	Sum..............	776	801	811	801	770	632	520	405
	Mean	77.6	80.1	81.1	80.1	77.0	63.2	52.0	40.5

Triangle, Lon. 60° E., Equa., & Lon. 150° E.	E. 60	77	80	85	96	87	76	64	45
	70	76	79	82	93	91	76	66	45
	80	77	85	84	88	94	76	66	45
	90	78	81	82	86	90	75	67	49
	100	80	80	81	86	86	76	68	50
	110	81	83	85	86	83	76	69	50
	120	80	81	82	84	78	75	70	50
	130	80	80	80	80	72	73	69	52
	140	80	79	79	78	71	67	63	54
	150	80	79	78	77	68	57	53	52
	Sum	789	807	818	854	820	727	655	492
	Mean	78.9	80.7	81.8	85.4	82.0	72.7	65.5	49.2

readings for the circle of 80° N. Tables 1 to 4 show the results of this method.

4. July Latitude Temperatures in Opposite Spherical Triangles.

	Longitude.	Equa.	N. 10	20	30	40	50	60	70
Triangle, Lon. 120° W., Equa., & Lon. 150° E.	W. 120	77	78	76	69	80	70	66	40
	130	77	78	75	67	59	57	63	42
	140	78	78	76	69	60	56	57	40
	150	78	78	77	71	61	55	57	40
	160	78	79	77	73	62	54	53	39
	170	78	79	78	75	64	53	45	36
	180	78	79	78	76	66	52	43	38
	170	78	78	78	76	67	50	44	42
	160	79	79	78	76	67	59	50	50
	E. 150	80	79	78	77	68	57	53	52
	Sum	781	785	771	729	654	563	531	419
	Mean............	78.1	78.5	77.1	72.9	65.4	56.3	53.1	41.9
Triangle, Lon. 30° W., Equa., & Lon. 60° E.	W. 30	78	81	78	75	71	58	51	41
	20	78	80	78	74	71	60	53	40
	10	77	80	85	72	72	61	54	40
	Greenwich 0	75	81	90	92	80	65	54	43
	10	74	80	95	95	78	69	61	48
	20	81	88	98	87	79	70	61	52
	30	83	90	97	84	80	70	64	54
	40	81	90	89	91	85	72	65	49
	50	79	84	91	88	82	75	65	47
	E. 60	77	80	85	96	87	76	64	45
	Sum.............	783	834	886	854	785	676	592	459
	Mean	78.3	83.4	88.6	85.4	78.5	67.6	59.2	45.9

By the second method the isotherms around the Pole were approximately sketched in following the hints given by the isotherms upon Buchan's Polar Chart, and thirty-six observations taken upon 80° north latitude in the usual way of interpolating. The mean obtained from this method (the results of which are included in Tables I. and II.) corresponded with remarkable closeness to the graphical mean of Dove's method, being but 0.34° warmer in January, and 0.13° colder in July.

The normal for the latitude being once determined, as in Tables I., II., and III., a comparison of the reading of each station with the normal temperature of its latitude gave the departure or anomaly of the station, as in Tables IV., V., and VI. In discarding the fractions of a degree to obtain a simple normal, however (as in Table VI. for example, 1.6° is considered as 2.0°, and 68.4° as 68.0°), a certain amount of accuracy was sacrificed.

I. JANUARY MEAN TEMP. (FAHR.) OF EACH 10TH DEGREE OF LATITUDE.

LON. W.	N. 80	70	60	50	40	30	20	10	Eq.	10	20	30	40	50	60 S
180	−46	−23	+25	+37	52	63	71	75	78	80	77	72	65	53	37
170	−45	−18	+25	+39	46	64	71	74	78	79	77	71	66	54	38
160	−43	−19	+10	+42	57	65	70	74	78	78	76	71	66	54	38
150	−43	−23	+25	+45	58	65	70	74	78	78	75	70	66	54	36
140	−44	−24	+23	+47	58	64	70	75	78	78	75	70	65	53	35
130	−44	−25	0	+44	56	63	70	75	79	78	74	69	64	51	35
120	−43	−25	−12	+25	47	60	70	76	79	77	74	69	62	49	35
110	−41	−35	−15	+10	49	62	70	78	79	77	73	68	59	47	35
100	−40	−35	−22	− 3	33	55	76	80	78	75	72	66	57	46	34
90	−40	−29	−27	+ 2	29	53	69	83	77	74	70	63	56	46	35
80	−37	−27	−25	0	35	60	75	85	79	73	68	64	56	48	35
70	−33	−22	−18	0	36	65	76	84	79	77	73	65	65	54	36
60	−31	− 7	− 3	+ 6	46	66	75	77	79	81	86	80	71	53	37
50	−31	0	+18	+24	50	66	74	78	80	85	86	76	66	50	37
40	−32	− 4	+23	+39	55	66	73	77	81	85	82	72	63	48	36
30	−29	+ 3	+32	+46	58	65	73	78	82	81	77	69	59	46	34
20	−27	+13	+38	+49	59	64	71	77	81	79	74	67	56	45	33
W. 10	−25	+20	+41	+48	55	62	72	81	80	77	72	64	54	45	34
G'n'h. 0	−22	+24	+40	+42	49	62	73	83	78	75	69	62	53	44	35
E. 10	−18	+30	+28	+34	51	62	71	85	80	76	68	61	52	44	35
20	−15	+27	+24	+28	51	60	71	85	86	85	83	78	53	43	35
30	−12	+20	+18	+22	44	60	75	85	88	91	91	78	55	43	35
40	−13	+15	+12	+18	48	61	76	82	85	85	79	71	56	43	34
50	−15	+ 6	+ 6	+11	40	57	70	79	81	81	77	69	55	43	34
60	−15	− 5	+ 2	+ 4	37	62	74	77	80	81	77	66	54	43	35
70	−13	−17	− 7	+ 3	40	60	72	78	81	81	76	65	53	43	35
80	−15	−24	− 9	+ 4	31	59	73	79	82	80	75	65	53	43	34
90	−20	−31	−10	+ 2	30	56	70	79	83	80	75	65	53	43	34
100	−23	−38	−17	− 3	29	54	70	78	81	81	76	66	54	44	34
110	−26	−43	−22	− 7	24	47	64	78	80	82	80	68	55	44	33
120	−28	−47	−29	− 8	15	42	68	78	80	83	88	80	56	45	33
130	−31	−45	−27	−13	20	45	72	77	80	85	92	75	57	45	33
140	−34	−44	−18	− 5	29	50	72	77	80	83	85	83	61	45	33
150	−37	−40	−10	+12	35	55	72	76	79	81	82	82	63	47	33
160	−42	−35	− 4	+25	39	57	71	76	78	81	81	73	62	50	34
170	−45	−30	+ 6	+32	46	61	71	76	78	81	79	73	62	52	35
E. 180	−46	−23	+25	+37	52	63	71	75	78	80	78	72	65	53	37
Mean....	−30.91	−15.66	3.94	19.94	42.94	59.48	71.67	78.48	80.00	80.01	77.61	70.02	59.13	47.37	34.89

The minus departures should, of course, equal the plus, but as a matter of fact in the tables the two totals are usually far from equal, the minus sum of a column of departures being in excess when the normal has been taken greater than the true figure, and the plus total when the normal has been taken too small. Still, there seemed no way out of this difficulty, for the scale of the work has not warranted the use of fractional degrees.*

The anomalies, having been calculated from the tables of observations, were then entered on a Mercator's chart at their proper stations; and just as isothermal lines connect points of equal heat, so were drawn isanomalous lines, connecting points of equal departure from the normal of their latitude. In the first

II. JULY MEAN TEMP. (FAHR.) OF EACH 10TH DEGREE OF LATITUDE.

LON.	N. 80	70	60	50	40	30	20	10	Eq.	10	20	30	40	50	60 S.
W. 180	25	38	43	52	66	76	78	79	78	78	73	60	48	38	-
170	24	36	45	53	64	75	78	79	78	77	70	60	49	39	-
160	24	39	53	54	62	73	77	79	78	76	69	59	50	40	-
150	25	40	57	55	61	71	77	78	78	76	69	59	50	41	-
140	28	40	57	56	60	69	76	78	78	76	68	59	50	41	30
130	30	42	63	57	59	67	75	78	77	76	68	59	50	41	30
120	32	40	66	70	80	69	76	78	77	74	67	58	50	40	30
110	33	39	62	75	95	90	78	78	76	72	65	57	48	40	30
100	33	40	57	72	85	91	90	78	75	70	62	55	47	40	-
90	34	40	53	66	80	83	84	79	74	65	58	53	46	39	-
80	35	39	47	63	77	81	83	81	76	64	57	51	44	37	-
70	36	40	45	62	71	80	82	81	79	75	60	55	47	38	-
60	36	41	45	56	70	79	81	82	80	77	69	55	45	37	-
50	37	42	47	55	70	77	80	82	81	78	70	55	44	36	-
40	36	41	47	55	71	76	79	81	80	77	68	56	44	35	-
30	35	41	51	58	71	75	78	81	78	76	68	57	44	35	-
20	34	40	53	60	71	74	78	80	78	75	67	56	44	35	-
10	34	40	54	61	72	72	85	80	77	73	65	55	44	35	-
Gh. 0	35	43	54	65	80	92	90	81	75	70	62	53	44	35	-
10	36	48	61	69	78	95	95	80	74	65	60	52	45	35	-
20	38	52	61	70	79	87	98	88	81	75	68	58	45	35	-
30	38	54	64	70	80	84	97	90	83	77	72	61	47	35	-
40	38	49	65	72	85	91	89	90	81	76	71	61	48	35	-
50	37	47	65	75	82	88	91	84	79	76	70	61	48	35	-
60	35	45	64	76	87	96	85	80	77	75	70	61	48	35	-
70	34	45	66	76	91	93	82	79	76	74	69	60	48	35	-
80	33	45	66	76	94	88	84	85	77	74	68	60	48	35	-
90	32	49	67	75	90	86	82	81	78	75	67	59	47	35	-
100	32	50	68	76	86	86	81	80	80	76	67	58	47	36	-
110	32	50	69	76	83	86	85	83	81	77	66	57	46	36	-
120	31	50	70	75	78	84	82	81	80	76	65	55	46	36	-
130	31	52	69	73	72	80	80	80	80	77	66	55	46	35	-
140	32	54	63	67	71	78	79	79	80	78	65	54	47	35	-
150	31	52	53	57	68	77	78	79	80	79	66	54	47	35	-
160	30	50	50	59	67	76	78	79	79	78	67	56	48	36	-
170	27	42	44	50	67	76	78	78	78	78	70	58	47	36	-
E. 180	25	38	43	52	66	76	78	78	78	78	72	60	48	38	-
Mean....	32.37	44.13	56.94	64.56	75.37	81.00	82.35	80.73	78.24	74.94	66.86	57.08	46.86	36.75	-

* In interpolating on the charts, when two consecutive readings were manifest half-degrees, the first was entered half a degree too high and the second half a degree too low.

charts prepared in this manner, a difficulty arose about connecting the o's, or points which, having the normal temperature of their latitude, were of no departure. The wide normal region of the South Pacific, for example, could scarcely be represented by a *line*. In the latter charts, therefore, the isanomalous lines were started at +2° and —2°, leaving between them a *belt* of normal or nearly normal temperature. The isanomals were continued at intervals of 4° F., as this scale was found convenient for showing the maxima of both plus and minus departures.

Before examining the charts, a glance may be given at the comparative table (VII.) of new and old latitude normals. The figures given by Ferrel are taken from his work, "On the Mechanics and General Motions of the Atmosphere," Part I. of "Meteorological Researches," Washington, 1877. Teisserenc

III. ANNUAL MEAN TEMPERATURE (FAHR.) OF EACH 10TH DEGREE OF LATITUDE.

LON.	N. 80	70	60	50	40	30	20	10	Eq.	10	20	30	40	50	60 S.
W. 180	— 3	11	29	42	50	62	73	78	79	78	75	66	57	45	30
170	— 2	10	29	42	50	61	72	78	79	78	75	66	57	46	30
160	— 3	9	32	44	50	60	71	78	79	78	75	65	57	46	31
150	— 4	7	40	45	50	60	70	78	79	78	74	65	57	46	31
140	— 5	6	40	47	52	59	68	77	79	78	73	65	56	46	31
130	— 8	10	35	47	53	59	67	77	78	78	72	64	56	45	32
120	—10	8	28	48	65	60	69	77	78	77	71	63	56	44	32
110	— 7	3	23	45	71	76	74	78	78	75	69	62	55	44	32
100	— 6	1	19	36	59	72	84	79	77	72	67	61	54	44	32
90	— 4	3	15	33	55	69	77	79	76	70	65	60	53	43	33
80	— 1	7	13	32	56	70	79	80	78	70	64	60	52	43	34
70	+ 1	11	15	33	53	72	80	82	80	77	65	63	54	45	35
60	+ 3	16	22	32	55	73	80	82	81	81	80	68	58	46	34
50	+ 6	23	31	41	57	72	78	82	83	82	80	70	57	45	32
40	+ 7	25	37	50	62	71	77	81	82	81	78	69	57	44	29
30	+ 7	26	41	53	64	70	75	80	81	79	75	67	56	42	-
20	+ 8	28	44	54	63	70	74	79	79	77	73	65	55	41	-
10	+10	29	45	53	61	67	79	84	78	75	71	62	53	39	-
Gh. 0	+12	32	46	51	62	74	83	85	77	72	67	61	52	39	-
10	+14	36	43	50	62	76	83	85	78	73	68	60	51	38	-
20	+15	37	40	50	65	72	83	87	83	80	80	70	52	38	-
30	+15	31	39	47	61	71	83	88	86	83	81	73	53	38	-
40	+13	26	37	46	62	74	82	85	84	80	77	68	54	39	-
50	+12	20	35	44	60	75	81	84	82	78	75	65	53	40	-
60	+ 9	14	32	43	63	77	82	82	81	78	75	64	52	40	-
70	+ 6	12	30	42	66	78	80	83	81	78	74	63	51	39	-
80	+ 3	9	28	41	65	78	84	84	80	77	74	62	50	38	-
90	+ 1	8	28	42	62	74	80	82	79	77	73	62	49	37	-
100	0	7	26	42	60	70	77	81	80	78	74	62	49	37	-
110	— 2	4	23	39	56	66	76	81	82	80	75	63	50	37	-
120	— 3	0	20	36	51	63	75	81	82	81	79	66	50	36	-
130	— 4	—3	17	33	48	65	76	81	81	84	82	66	52	37	-
140	— 5	+4	20	33	49	65	76	78	79	82	78	70	55	38	-
150	— 5	8	22	35	49	64	76	78	79	81	75	68	56	40	-
160	— 5	9	23	38	48	63	75	78	79	81	74	66	57	43	-
170	— 3	10	25	40	49	62	74	78	79	80	75	65	57	44	-
E. 180	— 2	11	29	42	50	61	73	78	79	78	75	66	57	45	-
Mean.....	1.62	13.73	29.75	42.46	57.13	68.40	76-91	80.75	79.86	78.24	73.86	64.89	54.05	41.54	-

de Bort gives only the January and July temperatures,* but the ½ (January + July) is easily calculated. In the first three sections it will be noted that the new tables give greater extremes of cold in the high latitudes, as well as generally greater extremes of heat near the equator, than previously observed. The annual mean, as newly determined, bears out the remark of Dove † that "The mean annual temperature derived from the twelve monthly means agrees very nearly with the mean between the warmest and the coldest month." ‡ Dove's figures themselves agree with the new in a remarkable manner, considering the circumstances of their determination. Indeed, all the

IV. January Departures from the Latitude Normals.

Lon.	N. 80°	70°	60°	50°	40°	30°	20°	10°	0°	10°	20°	30°	40°	50°	60° S.
Mean.	−30.9	−15.7	3.9	19.9	42.9	59.5	71.7	78.5	80.0	80.0	77.6	70.0	59.1	47.4	34.9
W. 180	−15	−7	21	17	9	3	−1	−3	−2	0	−1	2	6	6	2
170	−14	−2	21	19	3	4	−1	−4	−2	−1	−1	1	7	7	3
160	−12	−3	6	22	14	5	−2	−4	−2	−2	−2	1	7	7	3
150	−12	−7	21	25	15	5	−2	−4	−2	−2	−3	0	7	7	1
140	−13	−8	19	27	15	4	−2	−3	−2	−2	−3	0	6	6	0
130	−13	−9	−4	24	13	3	−2	−3	−1	−2	−4	−1	5	4	0
120	−12	−9	−16	5	4	0	−2	−2	−1	−3	−4	−1	3	2	0
110	−10	−19	−19	−10	6	2	−2	0	−1	−3	−5	−2	0	0	0
100	−9	−19	−26	−23	−10	−5	4	2	−2	−5	−6	−4	−2	−1	−1
90	−9	−13	−31	−18	−14	−7	−3	5	−3	−6	−8	−5	−3	−1	0
80	−6	−11	−29	−20	−8	0	3	7	−1	−7	−10	−6	−3	1	0
70	−2	−6	−22	−20	−7	5	4	6	−1	−3	−5	−5	6	7	1
60	0	9	−7	−14	3	6	3	−1	−1	1	8	10	12	6	2
50	0	16	14	4	7	6	2	0	0	5	8	6	7	3	2
40	−1	12	19	19	12	6	1	−1	1	5	4	2	4	1	1
30	2	19	28	26	15	5	1	0	2	1	−1	−1	0	−1	−1
20	4	29	34	29	16	4	−1	−1	1	−1	−4	−3	−3	−2	−2
10	6	36	37	28	12	2	0	3	0	−3	−6	−6	−5	−2	−1
Gh. 0	9	40	36	22	6	2	1	5	−2	−5	−9	−8	−6	−3	0
10	13	46	24	14	8	2	−1	7	0	−4	−10	−9	−7	−3	0
20	16	43	20	8	8	0	−1	7	6	5	5	8	−6	−4	0
30	19	36	14	2	1	0	3	7	8	11	13	8	−4	−4	0
40	18	31	8	−2	5	1	4	4	5	5	1	1	−3	−4	−1
50	16	22	2	−9	−3	−3	−2	1	1	1	−1	−1	−4	−4	−1
60	16	11	−2	−16	−6	2	2	−1	0	1	−1	−4	−6	−4	0
70	18	−1	−11	−17	−3	0	0	0	1	1	−2	−5	−5	−4	0
80	16	−8	−13	−16	−12	−1	1	1	2	0	−3	−5	−6	−4	−1
90	11	−15	−14	−18	−13	−4	−2	1	2	0	−3	−5	−6	−4	−1
100	8	−22	−21	−23	−14	−6	−2	0	1	1	−2	−4	−5	−3	−1
110	5	−27	−26	−27	−19	−13	−8	0	0	2	2	−2	−4	−3	−2
120	3	−31	−33	−28	−28	−18	−4	0	0	3	10	10	−3	−2	−2
130	0	−29	−31	−33	−23	−15	0	−1	0	5	14	5	−2	−2	−2
140	−3	−28	−22	−25	−14	−10	0	−1	0	3	7	13	2	−2	−2
150	−6	−24	−14	−8	−8	−5	0	−2	−1	1	4	12	4	0	−2
160	−11	−19	−8	5	−4	−3	−1	−2	−2	1	3	3	3	3	−1
E. 170	−14	−14	2	12	3	1	−1	−2	−2	1	1	3	3	5	0

* In °C. like all his work. Dove is all in Réamur.

† Dist. Heat, p. 15.

‡ Yet to consider with Ferrel that ½ (January + July) gives the normal of the year is unsafe, as the new charts show a difference always exists, in one case of more than 2° F. (40° N.)

results of actual observation (setting aside the interesting but untrustworthy formulated normals of Forbes and Zenker) agree so closely that it is plain corrections of the normals must henceforth be a matter of decimals more than of whole degrees, and that the variations from these normals should occupy the principal share of our attention. The charting of these variations, therefore, becomes the most interesting part of the investigation.

In examining the new charts of isanomalies, the zero line, while not without a theoretic interest, is so difficult to determine, as already mentioned, that, notwithstanding Dove and Teisserenc de Bort both mark it carefully, it is here passed over, and the discussion is limited to the most striking and important part of the subject, the areas of greatest departure, or maxima and minima. Table VIII. is an attempt to show the main alterations that the new charts have made in the results of Dove

V. JULY DEPARTURES FROM THE LATITUDE NORMALS.

LON.	N. 80	70°	60°	50°	40°	30°	20°	10°	0°	10°	20°	30°	40°	50°	60° S.
Mean	32.4	44.1	56.9	64.6	75.4	81.0	82.4	80.7	78.2	74.9	66.9	57.1	46.9	36.8	-
W. 180	−7	−6	−14	−13	−9	−5	−4	−2	0	3	6	3	1	1	-
170	−8	−8	−12	−12	−11	−6	−4	−2	0	2	3	3	2	2	-
160	−8	−5	−4	−11	−13	−8	−5	−2	0	1	2	2	3	3	-
150	−7	−4	0	−10	−14	−10	−5	−3	0	1	2	2	3	4	-
140	−4	−4	0	−9	−15	−12	−6	−3	0	1	1	2	3	4	-
130	−2	−2	6	−8	−16	−14	−7	−3	−1	1	1	2	3	4	-
120	0	−4	9	5	5	−12	−6	−3	−1	−1	0	1	3	3	-
110	1	−5	5	10	20	9	−4	−3	−2	−3	−2	0	1	3	-
100	1	−4	0	7	10	10	8	−3	−3	−5	−5	−2	0	3	-
90	2	−4	−4	1	5	2	2	−2	−4	−10	−9	−4	−1	2	-
80	3	−5	−10	−2	2	0	1	0	−2	−11	−10	−6	−3	0	-
70	4	−4	−12	−3	−4	−1	0	0	1	0	−7	−2	0	1	-
60	4	−3	−12	−9	−5	−2	−1	1	2	2	2	−2	−2	0	-
50	5	−2	−10	−10	−5	−4	−2	1	3	3	3	−2	−3	−1	-
40	4	−3	−10	−10	−4	−5	−3	0	2	2	1	−1	−3	−2	-
30	3	−3	−6	−7	−4	−6	−4	0	0	1	1	0	−3	−2	-
20	2	−4	−4	−5	−4	−7	−4	−1	0	0	0	−1	−3	−2	-
10	2	−4	−3	−4	−3	−9	3	−1	−1	−2	−2	−2	−3	−2	-
Gh. 0	3	−1	−3	0	5	11	8	0	−3	−5	−5	−4	−3	−2	-
10	4	4	4	4	2	14	13	−1	−4	−10	−7	−5	−2	−2	-
20	6	8	4	5	4	6	16	7	3	0	1	1	−2	−2	-
30	6	10	7	5	5	3	15	9	5	2	5	4	0	−2	-
40	6	5	8	7	10	10	7	9	3	1	4	4	1	−2	-
50	5	3	8	10	7	7	9	3	1	1	3	4	1	−2	-
60	3	1	7	11	12	15	3	−1	−1	0	3	4	1	−2	-
70	2	1	9	11	16	12	0	−2	−2	−1	2	3	1	−2	-
80	1	1	9	11	19	7	2	4	−1	−1	1	3	1	−2	-
90	0	5	10	10	15	5	0	0	0	0	0	2	0	−2	-
100	0	6	11	11	11	5	−1	−1	2	1	0	1	0	−1	-
110	0	6	12	11	8	5	3	2	3	2	−1	0	−1	−1	-
120	−1	6	13	10	3	3	0	0	2	1	−2	−2	−1	−1	-
130	−1	8	12	8	−3	−1	−2	−1	2	2	−1	−2	−1	−2	-
140	0	10	6	2	−4	−3	−3	−2	2	3	−2	−3	0	−2	-
150	−1	8	−4	−8	−7	−4	−4	−2	2	4	−1	−3	0	−2	-
160	−2	6	−7	−6	−8	−5	−4	−2	1	3	0	−1	1	−1	-
E. 170	−5	−2	−13	−15	−8	−5	−4	−3	0	3	3	1	0	−1	-

VI. ANNUAL DEPARTURES FROM THE LATITUDE NORMALS.

LON.	N. 80	70°	60°	50°	40°	30°	20°	10°	0°	10°	20°	30°	40°	50°	60° S.
Mean	1.6	13.7	29.8	42.5	57.1	68.4	76.9	80.8	79.9	78.2	73.9	64.9	54.0	41.5	-
W. 180	−5	−3	−1	0	−7	−6	−4	−3	−1	0	1	1	3	3	-
170	−4	−4	−1	0	−7	−7	−5	−3	−1	0	1	1	3	4	-
160	−5	−5	2	2	−7	−8	−6	−3	−1	0	1	0	3	4	-
150	−6	−7	10	3	−7	−8	−7	−3	−1	0	0	0	3	4	-
140	−7	−8	10	5	−5	−9	−9	−4	−1	0	−1	0	2	4	-
130	−10	−4	5	5	−4	−9	−10	−4	−2	0	−2	−1	2	3	-
120	−12	−6	−2	6	8	−8	−8	−4	−2	−1	−3	−2	2	2	-
110	−9	−11	−7	3	14	8	−3	−3	−2	−3	−5	−3	1	2	-
100	−8	−13	−11	−6	2	6	7	−2	−3	−6	−7	−4	0	2	-
90	−6	−11	−15	−9	−2	1	0	−2	−4	−8	−9	−5	−1	1	-
80	−3	−7	−17	−10	−1	2	2	−1	−2	−8	−10	−5	−2	1	-
70	−1	−3	−15	−9	−4	4	3	1	0	−1	−9	−2	0	3	-
60	1	2	−8	−10	−2	5	3	1	1	3	6	3	4	4	-
50	4	9	1	−1	0	4	1	1	3	4	6	5	3	3	-
40	5	11	7	8	5	3	0	0	2	3	4	4	3	2	-
30	5	12	11	11	7	2	−2	−1	1	1	1	2	2	0	-
20	6	14	14	12	6	2	−3	−2	−1	−1	−1	0	1	−1	-
10	8	15	15	11	4	−1	2	3	−2	−3	−3	−3	−1	−3	-
Gh. 0	10	18	16	9	5	6	6	4	−3	−6	−7	−4	−2	−3	-
10	12	22	13	8	5	8	6	4	−2	−5	−6	−5	−3	−4	-
20	13	23	10	8	8	4	6	6	3	2	6	5	−2	−4	-
30	13	17	9	5	4	3	6	7	6	5	7	8	−1	−4	-
40	11	12	7	4	5	6	5	4	4	2	3	3	0	−3	-
50	10	6	5	2	3	7	4	3	2	0	1	0	−1	−2	-
60	7	0	2	1	6	9	5	1	1	0	1	−1	−2	−2	-
70	4	−2	0	0	9	10	3	2	1	0	0	−2	−3	−3	-
80	1	−5	−2	−1	8	10	7	3	0	−1	0	−3	−4	−4	-
90	−1	−6	−2	0	5	6	3	1	−1	−1	−1	−3	−5	−5	-
100	−2	−7	−4	0	3	2	0	0	0	0	0	−3	−5	−5	-
110	−4	−10	−7	−3	−1	−2	−1	0	2	2	1	−2	−4	−5	-
120	−5	−14	−10	−6	−6	−5	−2	0	2	3	5	1	−4	−6	-
130	−6	−17	−13	−9	−9	−3	−1	0	1	6	8	1	−2	−5	-
140	−7	−10	−10	−9	−8	−3	−1	−3	−1	4	4	5	1	−4	-
150	−7	−6	−8	−7	−8	−4	−1	−3	−1	3	1	3	2	−2	-
160	−7	−5	−7	−4	−9	−5	−2	−3	−1	3	0	1	3	1	-
E. 170	−5	−4	−5	−2	−8	−6	−3	−3	−1	2	1	0	3	2	-

VII. VARIOUS LATITUDE NORMALS, FAHRENHEIT.

LATITUDE.	N. 80°	70°	60°	50°	40°	30°	20°	10°	0°	10°	20°	30°	40°	50°	60° S.
January.															
NEW CHART	—30.9	—15.7	3.9	19.9	42.9	59.5	71.7	78.5	80.0	80.0	77.6	70.0	59.1	47.4	34.9
T. DE BORT	—20.4	—11.9	3.6	19.8	40.3	58.6	69.0	77.2	79.7	79.5	77.5	72.1	63.1	53.2	–
FERREL	—25.0	—15.5	1.7	21.3	40.0	55.2	71.0	78.7	81.2	82.2	80.0	73.4	63.8	52.0	38.5
July.															
NEW CHART	32.4	44.1	56.9	64.6	75.4	81.0	82.4	80.7	78.2	74.9	66.9	57.1	46.9	36.8	–
T. DE BORT	34.0	45.7	56.3	62.6	72.3	78.4	81.7	80.8	77.9	73.0	67.6	60.4	52.2	39.9	–
FERREL	34.1	44.3	57.0	65.5	73.0	80.0	84.2	83.2	79.0	75.2	69.5	60.1	52.0	43.5	32.0
½ (January + July).															
NEW CHART	0.7	14.2	30.4	42.3	59.2	70.2	77.0	79.6	79.2	77.5	72.2	63.6	53.0	42.0	–
T. DE BORT	6.8	16.9	29.9	41.2	56.3	68.5	75.8	79.0	78.8	76.3	72.6	66.3	57.6	46.6	–
FERREL	4.5	14.4	29.3	43.4	56.5	67.6	77.6	81.0	80.1	78.7	74.7	66.7	57.9	47.8	35.3
The Year.															
NEW CHART	1.6	13.7	29.8	42.5	57.1	68.4	76.9	80.8	79.9	78.2	73.9	64.9	54.0	41.5	–
DOVE (1846)	6.8	16.0	30.2	41.7	56.5	69.8	77.5	79.9	79.7	–	–	–	–	–	–
FORBES (1859)*	6.5	16.1	28.6	42.5	56.2	67.9	76.4	80.5	79.8	–	–	–	–	–	–
HANN (1872)	–	–	–	–	56.5	69.8	77.4	79.9	79.7	77.9	74.1	66.9	54.5	–	–
——— (1882)	–	–	–	–	–	–	–	–	78.8	78.6	74.1	65.8	55.4	43.7	32.5
ZENKER (1893)†	21.4	25.9	35.4	47.1	57.7	66.7	73.4	77.5	79.0 ‡	77.5	73.4	66.7	57.7	47.1	35.4

* On the Formula, "purely empirical," $T = 80.°8 \cos^2 (\lambda - 6° 30')$, when λ = latitude.
† On the Formula $\theta = I - 30°$ C. when I = *die Strahlung an der Grenze.*
‡ Humboldt estimated the mean temperature of the equator at 81.5°, Kirwan at 84°.

and De Bort.* It will be noted that in almost every case the extremes of temperature have been increased, that the areas too

VIII. JANUARY CRITERIA (DEG. FAHR.)

Name.		New Charts.		Teisserenc de Bort.		Dove.	
		Ring.	Single Reading.	Ring.	Single Reading.	Ring.	Single Reading
Maxima	Scandinavian	45	46°	36	-	40.5	45
	North Pacific	25	27°	-	25.2	18	22.5
	Australian	10	14°	-	7.2	4.5	-
	South African	10	13°	-	10.8	-	-
	South American	10	12°	-	7.2	9	-
Minima	Siberian	—30	—33°	—36	-	—36	—40.5
	Hudson's Bay	—30	—31°	—21.6	-	—22.5	-
	Cape Negro	—10	—10°	— 3.6	— 5.4	— 4.5	-
	Lima	—10	—10°	-	— 3.6	— 4.5	-

JULY CRITERIA.

Name.		New Charts. Ring.	New Charts. Single Reading.	Teisserenc de Bort. Ring.	Teisserenc de Bort. Single Reading.	Dove. Ring.	Dove. Single Reading
Maxima	Asian	10	19°	-	14.4	9	-
	Sahara	10	16°	-	18	9	-
	Denver	20	20°	-	18	-	-
Minima	Labrador	—10	—12°	-	—10.8	—11.7	-
	North Pacific	—10	—16°	—10.8	—10.8	—13.5	-
	Cape Negro	—10	—10°	-	— 3.6	— 4.5	-
	Lima	—10	—11°	-	— 3.6	— 9	—13.5

* It is interesting to note in the subjoined table the close agreement of these new charts with the set published in 1889 by R. Spitaler, assistant in the Vienna Observatory. ("*Ueber die Temperaturanomalien auf der Erdoberfläche in Januar und Juli.*" Petermann's "Mittheilungen," Dec., 1889.) His work, based on Hann's Isothermal Charts in Berghaus' "*Physikalischer Atlas,*" 1887, showed important changes on the work of previous investigators, and was, indeed, "an especially valuable contribution to the climatology of the earth." (Brückner.)

SPITALER'S CHARTS, Petermann's, December, 1889.

JANUARY CRITERIA.

Maxima: —

Scandinavian, better than the new charts, 24° C. *vs.* my 22.2° C.
N. Pacific, not so good in showing the current eddy.
Australian, better than the new, 8° C. *vs.* my 5.5° C.
S. African, not so good in *position* as the new charts.
S. American, same.

Minima: —

Siberian, better in "trend" and in readings than the new.
Hudson's Bay, not so good, position or observation,— 11° C. *vs.* my— 19.6° C.
C. Negro, better in "trend."
Lima, same.

JULY CRITERIA.

Maxima: —

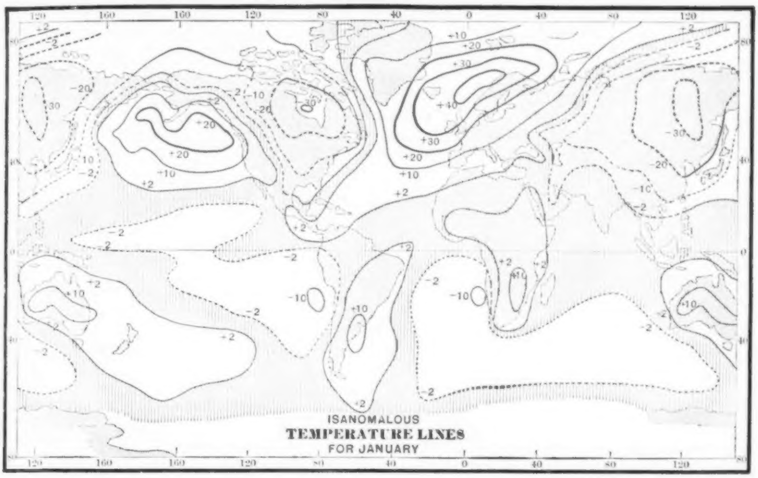
Asian, better, more accurately subdivided.
Sahara, same.
Denver, not so good; 10° F. *vs.* my 20° F.

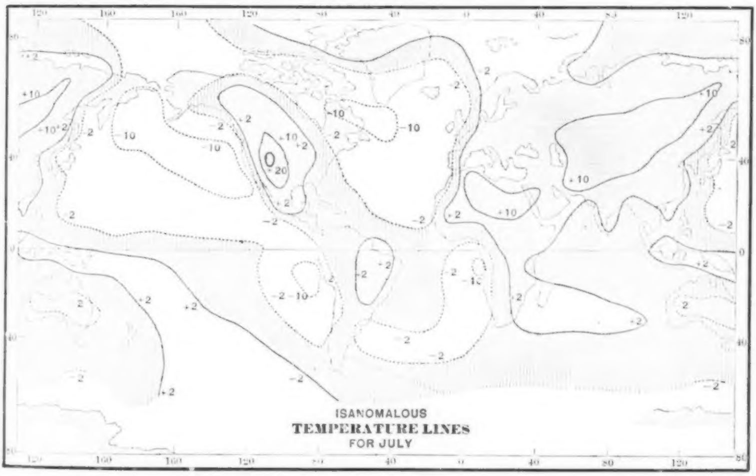
Minima: —

Labrador, not so good, smaller than the new charts.
N. Pacific, better, more accurately subdivided.
C. Negro, same.
Lima, same.

cool for their latitude-normal are now shown to be colder yet and areas too hot are now even hotter. Examine, for example, the July chart. The greatest maximum area is found in North America, central near Denver, where a plus temperature of 20° is reached. Dove does not give this area, and, in fact, as stated on page 454, leaves the interior of North America entirely uncharted for this month. De Bort gives this area a temperature of 10° C. (= 18° F.) and much larger proportions, extending from the west coast half way to the Mississippi. This maximum is the culmination of a plus area that extends roughly over both Americas. The main belt of plus temperature occurs in the eastern hemisphere, where Europe, Asia, and Africa, save for portions of the coast line, are all above the average temperature. Dove gives approximately the same showing, as does De Bort, though owing to his minute charting he gives many instructive details, enclosing the British Isles, for example, in a loop of normal temperature.

The too cool or minus areas of July afford the main interest of the chart. They extend over nearly all the Atlantic and the North Pacific basins, reaching minima along the coast of Labrador, in the North Pacific, off the west coast of South America (central off Lima), and off Cape Negro on the west coast of Africa. Dove places the first of these, or the Labrador minimum, further north, around the mouth of Hudson's Bay, while De Bort pushes it clear of the land into Davis's Straits. Dove's North Pacific area is confined to the ocean directly south of the straits, as if the polar "leakage" were the only cause of the low temperature; while De Bort divides his area in two, one under the straits and one off the west coast of North America. The Lima minimum remains almost unchanged from Dove's time, but De Bort makes it extremely vague and sweeping, at a minimum of only —3.6° F. He gives a small minimum of —27.° F. in the interior of lower South America that does not appear in any other charts. The African coast minimum is placed by Dove in the *middle* of the South Atlantic, most illogically, as we shall see, and only at —4.5° F.; while De Bort again is vague, covering the whole eastern half of the ocean with a sweeping, semi-conjectural —3.6° F. Both he and Dove give a minimum of —10.8° F. and —9° F., respectively, to Eastern Australia, a minimum which does not appear on the new charts save as a couple


ISANOMALOUS
TEMPERATURE LINES
FOR JANUARY


ISANOMALOUS
TEMPERATURE LINES
FOR JULY

of —3°'s. Both give minima of —7.2° F. and —4° F. off northwestern Africa, a minimum which in the new chart appears close inshore as —9° F.

Turning to the January chart, we find extremes of variation on every hand. Off the coast of Norway prevails the most extraordinary warmth, 40° Fahrenheit being recorded over a considerable area, and individual readings mounting as high as 46° Fahrenheit. Half as much is found in the maximum of the North Pacific, so cold six months before, while Australia, South Africa, and South America all rise 10° or more above their normal latitude temperatures. Dove pushes the Norway maximum far off the coast, with more contracted limits, but about the same readings. Teisserenc de Bort, on the other hand, elongates his area of greatest heat (36° Fahrenheit) nearly from Nova Zembla to Greenland, closely following the Gulf Stream. The North Pacific area shrinks under Dove to very small limits, with a maximum reading of 22.5° Fahrenheit, against the new 27° Fahrenheit. De Bort's corresponds closely to the new, with a maximum of 25.2° Fahrenheit. The Australian and South African plus areas are joined in Dove's chart by a long belt of 4.5° Fahrenheit, the ends of which fail to make a landing on either continent. De Bort goes to the other extreme, gives Australia a separate maximum of 7.2° Fahrenheit, and moves the African maximum plumply inland, at 10.8° Fahrenheit, extending from the equator fifteen degrees southward. The South American maximum remains practically unchanged from Dove, and is given as 72° by De Bort, who shows again his tendency to shove his areas inland, in contradiction to the theory of ocean currents, to be explained later.

The minima of January are in the eastern interior of Asia, the Hudson Bay region, or eastern interior of North America, and the spots off Lima and Cape Negro, which remain almost unchanged. There is also a slight minimum in the Sahara, beautifully illustrating a point to be mentioned below. The Asian and North American minima are much as found by Dove, save that he made the second somewhat more westerly, in which he is confirmed by De Bort. As usual, his figures are not as extreme as the new; but in the case of his lowest Asian reading, —40.5° Fahrenheit, the new charts for once modify, not increase, his results, the new reading being —33° Fahrenheit. Lima's mini-

mum falls with Dove to —4.5° Fahrenheit, and is entirely a piece of guesswork on De Bort's part, being dotted throughout, with a minimum observation of —3.6° Fahrenheit. The Cape Negro area is almost as vaguely indicated, with a minimum reading of —5.4° Fahrenheit. The Sahara minimum is given by Dove as —4.5° Fahrenheit, and by De Bort as low as —7.2° Fahrenheit, who joins it to the Asian "too cool" area.

The annual chart is not given by De Bort. Dove's is much like the new one, save that ignorance led him to connect in the western hemisphere the minus areas of Hudson's Bay and lower California, across the interior of North America (which is now found to be much hotter than we should expect from the average temperatures of its latitudes), and also to run his minus belt across the mid-Atlantic, joining the Hudson's Bay and the Cape Negro minima, over an area that is now also known to be above the average temperature of its latitude. The South America maximum, too, he does not chart; but his areas, though from 2° to 6° less extreme than the newer ones, are nearly identical in position with them, and his chart corresponds, in general, surprisingly well with the latest.

The *causes* of the irregularities of temperature distribution, as shown on these charts, may be grouped under two heads,— the irregular distribution of the land surfaces of the globe, or continental interruptions, and the circulation of the waters of the globe in fixed and natural directions, or ocean currents. These causes frequently combine, but several instances may be given of their individual effects.

The extremes of temperature to which the interiors of the continents are subjected are well known. Far from the equalizing influence of the ocean the absorptive power of rock and soil is unchecked, and the rays of the summer sun produce their maximum effect; while in winter the radiation is equally excessive and produces the greatest cold. This law is beautifully illustrated in the Siberian extremes, the same station (N. 60°, W. 120°) being 13° too hot for its latitude-normal in July, and 33° too cold in January. Of this character, too, are the maximum in North America during July (modified in January by its nearness to the coast) and the maxima in Australia, South Africa, and South America, during January, the summer of the southern hemisphere. These areas, like the North

American, are all modified in the winter (July) by the ocean, so that, with the exception of Australia, they all keep on the plus side of the line; but a very pretty instance of the pure law is given in the Sahara, a sandy and rocky plateau near the equator, where the conditions for absorption and radiation are well nigh perfect. In summer this region warms to a maximum of 16° F. above the normal of its latitude, but in winter, despite its nearness to the equator and the warm Mediterranean and Red Seas, it actually falls below its latitude mean temperature, as does the similar Arabian desert near by. A like effect is seen in Australia.

One case of continental, or apparently continental, cooling continues almost unmodified throughout the year. This is the great cold area around Hudson's Bay, always 10° too cool for its latitude, and often twice or even three times as much. This coolness arises from several causes. Among them are the vast ice-fields to the north, kept from shifting or breaking up by the Northern Archipelago; the great size of the bay, which cannot in the short summer rise much in temperature, and which is continually chilled by the ice-fields on its surface; and especially the influence of the cold Arctic current which sweeps forever down Davis Straits from the polar waters above.* This brings us to the cases of isanomalous belts created mainly by ocean currents.

Although undoubtedly the chief cause of irregularities of temperature distribution, ocean currents were long entirely overlooked in the enumeration of causes. Even Humboldt omits them in his exhaustive list of "modifying causes."† Not only do currents play the leading part in producing the irregularities of temperature, but these very irregularities give a beautiful and conclusive proof of the existence and qualities of an orderly system of ocean currents throughout all the ocean basins of the globe. Take, for example, the North Pacific, an ocean practically closed at the northern end, and considerably shut off by the Coral Islands at the southern — the type, in fact, of a

* The summer warming of the continent pushes this minimum off the coast, in which position it has been called the Labrador Minimum; but the Annual Chart shows the identity of the two areas.

† "Des Lignes Isothermes et de la Distribution de la Chaleur sur la Globe." Mém. Phys. Chim. Arcueil, 1817. Translation in Edinb. Phil. Journ., 1820–21.

closed ocean. Observe how the water of the tropics, warmer in January than the temperature of the chilled northern continents, sweeping up in the right-handed eddy characteristic of the northern hemisphere, produces all over the northern part of the basin an area of temperature above the normal, rising even to +27°. The *direction* of the current could not be more prettily proved than by the way in which it is shunted off the west coast of Alaska, and forms a true back-water eddy behind the projecting Alaskan Peninsula. In July, when the waters of the northern hemisphere are generally colder than the land, the effects of this current are even more plainly shown, this time in a too cool area. The Southern Pacific current, on the contrary, moving in the left-handed eddy of the southern hemisphere, produces from the warm tropical water it brings *down* a maximum area over its entire southwestern portion, and a very neat minimum off the west coast of South America, central about the latitude of Lima, evidently the result of the cold Antarctic water brought *up* in the eddy. This maximum and minimum appear nearly as constants on all the charts. A similar pair appears in the South Atlantic, where, however, the enormous issue of warm water from the mouth of the Amazon introduces the plus area at a much earlier point of the western and southern current, as shown with particular neatness on the chart for July. In this case, moreover, the warm southern current augmented by the issue from La Plata contributes to produce the summer (January) maximum, central near Buenos Ayres. Northward and eastward the cold current of this eddy, sneaking round the corner of Sierra Leone, runs up in January considerably past the equator.

The minimum central off Cape Negro, proving so strikingly the theory of the ocean currents, since it is caused by the cold Antarctic water brought up in the left-handed eddy characteristic of the southern oceans, seems in these charts placed for the first time where theory and observation agree. Dove located it, as mentioned on page 468, nearly in the middle of the ocean, where it was totally unaccountable; and De Bort did little better, making it so large, vague (dotted lines and few figures), and moderate (maximum observation, 5.4° Fahrenheit) that its real significance was almost lost.

Once more the characteristic eddy of the southern hemisphere

is exemplified by the temperature variations in the Indian Ocean, wherein the eastern or Antarctic-water side is almost uniformly colder than the western or tropical-water side. As the continental interruptions of the southern hemisphere are much less than those of the northern, and the character of the interiors of South America and Africa is such that extremes of absorption and radiation are of rare occurrence, the ocean has an almost unimpeded sway, and keeps the variations nearly constant throughout the year, as the charts indicate.

In the northern hemisphere, on the contrary, the case is far otherwise. We have seen the alternate maximum and minimum produced by the North Pacific eddy, and we now come to the most remarkable instance of temperature anomaly on the globe, that, namely, off the coast of Norway, produced by the so-called Gulf Stream. To the west of the North Cape, during January, the temperature actually rises 46° above the average for the latitude, and for the year reaches +23°, an anomaly unapproached in any other region, and extending over Europe an influence as important as it is widespread. This extraordinary warmth seems entirely due to the ocean currents. The tropical waters, well warmed in the cauldron of the Caribbean, are brought up the North American coast by the right-handed eddy of the North Atlantic, and caught by the lower rim of the Arctic eddy, which "gears into" the Atlantic whirl, thus turning in a left-handed current. Up the south and east edges of the Arctic basin, then, the warm water is carried across the Atlantic and past the Scandinavian Peninsula, preserving its high temperature till finally lost amid the ice-fields of the Siberian coast.

The annual chart gives the mean results of all the foregoing causes. As a general rule the continents of the northern hemisphere are seen to have cold eastern and warm western margins, as was observed by Forster as early as 1794*. In the southern hemisphere this rule is reversed ; or, to put the converse, the southern oceans have cold eastern and warm western shores. Of the continents, North America enjoys the distinction of possessing two wholly inland extremes, a maximum in the Rocky Mountains and a minimum over Hudson's Bay. South America, on the contrary, is the most equable of all the continents, pos-

* Dove, Dist. Heat, p. 5.

sessing but one slight maximum. Europe, Africa, and Australia are all too hot for their latitude-normals, while Asia and Oceanica are too cold. In the water hemisphere we find, as we should expect, great areas of nearly normal temperature, notably those of the South Pacific and the Indian Ocean. The observable trend of the isanomalous belts in a northwestern and southeastern direction is explainable, in nearly every case, either by the trend of the continental interruptions, as in the Americas, or by the "gearing" of the ocean eddies, as in the Pacific basin.*

We have now examined the chief phenomena of the variations in the earth's temperature distribution as deduced from the latest authority, with some considerations on their causes. Into their effects, upon climate, upon vegetable and animal life, upon man — his development, habits, industries, and history — we cannot here enter.

* The annual chart is not here printed.

CURRENT NOTES.

Notes on the Hurricane of October, 1893. — The hurricane which traversed the eastern part of the United States on Oct. 13 and 14, 1893, was a typical West India cyclone, and the second of its class that has crossed this district for a number of years. From the time of the appearance of the storm east of the Bahamas on the morning of Oct. 11, its course was accurately forecasted by the Weather Bureau, and ample warnings given throughout its entire path of its destructive character. On the morning of Oct. 13, the storm was central on the South Carolina coast, a barometer reading of 28.88 inches being reported at 6.45 A. M. at Charleston. On the evening of the 13th, it was central over northwestern North Carolina, the centre having passed Lynchburg about 5 P. M., with a pressure of 28.88 inches. The disturbance moved across Pennsylvania and Western New York, and was central north of Lake Ontario on the morning of the 14th. The hurricane did a great deal of damage along its course, especially in North and South Carolina, where it raised a high storm wave along the shore and on the lakes, so that shipping suffered considerably.

Gen. E. P. Alexander, formerly of the Corps of Engineers, U. S. Army, has very kindly sent to this JOURNAL a copy of the record he made during the storm at South Island, S. C., and as the disturbance passed centrally, or very nearly so, over that place, the data are especially interesting.

Gen. Alexander writes in connection with his observations as follows: "I regret very much that I did not record the temperature during the October gale, but having a rice crop and a good deal of property in the shape of mules, houses, etc., at risk, other aspects of it than the meteorological naturally occupied my attention. Still, I kept a pretty close record of the barometer . . . and estimated the wind velocities as carefully as I could. I noted the time and duration of the calm carefully, as I had never been at the centre of a cyclone before. . . . The barometer is a McQueen's mercurial "parlor" barometer. . . . It is not corrected for sea level or temperature. Its location is about 20 feet above mean high water. . . . As to my wind velocities, I had no instruments, and could only estimate to the best of my ability. I estimated the extreme velocity (in puffs) in (the) August (hurricane) at 100 miles, and in the October gale at 88 to 90. I am not an expert in this, and it may be too high."

Gen. Alexander made a rough set of curves showing the variations of barometer, wind velocity, and water level, based on his observations given above, and from these Mr. Reid Whitford, Assistant Engineer, U. S. Army, has drawn a more elaborate set, a copy of which has been sent to this JOURNAL. These curves are very interesting, although not strictly accurate. The pressure curve shows a fairly regular fall until shortly after

8 A. M., on Oct. 13, when the mercury fell quite rapidly until about ten, and then rose again rapidly till shortly after twelve, when the rise became gradual. The depression marking the passage of the centre is very symmetrical. The curve of estimated wind velocity shows a very sudden drop at about 9.40 A. M. on Oct. 13, to a dead calm just before 10 A. M., and then a sudden rise until about 10.45, after which the curve falls again unevenly. The curve representing the actual water level attains its greatest height about 9.30 A. M., coincident with the calm at the "Eye," and then falls very rapidly.

Barometer and Estimated Wind Velocities at South Island, South Carolina, October, 1893, Observed by E. P. Alexander.

Day.	Hour, by watch 32 minutes faster than local time. Longitude, 79° 15'.	Barometer.	Rate of rise or fall in $\frac{1}{100}$ per hour since previous reading.	Extreme velocity of wind.	Remarks.
Oct. 10	8 A. M.	30.08		12 N. E.	Clear.
Oct. 11	8 A. M.	30.00	— 0.33	15 N. E.	"
Oct. 12	8 A. M.	29.88	— 0.50	25 N. E.	Cloudy and occasional rain squalls.
" "	1.30 P. M.	29.75	— 1.75	28 N. E.	" " "
" "	5.30 P. M.	29 64	— 2 75	30 N. E.	" " "
" "	7.30 P. M.	29.60	— 2.	40 N. E.	" " "
" "	10 P. M.	29.53	— 1.50	50 N. E.	" " "
Oct. 13	12.30 A. M.	29.43	— 4.	60 N. E.	Cloudy. Rain squalls.
	2.30 A. M.	29.33	— 5.	65 N. E.	" "
	5.30 A. M.	29.19	— 4.67	70 N. E.	"
	7.30 A. M.	29.02	— 8.50	75 N. E.	" "
	8.15 A. M.	28 87	—20.	80 N. E.	"
	8.30 A. M.	28.80	—28.	85 E.	" "
	8.50 A. M.	28.68	—36.	88 E.	" Rain grows less.
	9 A. M.	28.58	—60.	88 N. E.	"
	9.15 A. M.	28.48	—40.	80 E.	"
	9.40 A. M.	28.28	—48.	20 E.	
	9.50 A. M.	28.24	—24.	0	Dead calm, warm, foggy, or fine mist. Sky lightens, sun almost visible.
	10 A. M.	28.26	+12.	0	No rain after this.
	10.10 A. M.	28.29	+18.	15 W.	Wind in alternate puffs and calms.
	10.25 A. M.	28.46	+68.	50 S. W.	Sky clearing, wind steady.
	10.45 A. M.	28.66	+60.	65 S. W.	
	11.05 A. M.	28.78	+36.	60 S. W.	Bright sunshine rest of the day.
	12 M.	28.98	+22.	50 S. W.	Note. — Barometer readings are mercurial. Wind velocities are estimated, not measured, and wind directions are not very accurate, as I had *no vane*, and trees and buildings prevented accuracy by causing cross currents. Time, fifteen minutes ahead of "*Eastern*."
	2 P. M.	29.18	+10.	40 S. W.	
	3 P. M.	29.28	+10.	30 S. W.	
	5.30 P. M.	29.40	+ 4.8	35 W.	
	9.30 P. M.	29.48	+ 2.	20 W.	

The normal high tide came about 10.30 A. M., so that the storm wave and the high tide combined to produce the extraordinarily high water at the time of the lowest barometer. It is a similar combination of circumstances which gives rise to the enormous destruction wrought by such storm waves on the low land at the head of the Bay of Bengal, in India, frequently noted in connection with the passage of cyclones from the bay on to the land in that region.

The Weather Bureau has issued Lake Storm Bulletin No. 2, to illustrate the path and characteristics of this hurricane.

Pilot Chart of the North Pacific Ocean. The Hydrographic Office of the United States Navy has issued an advance Pilot Chart of the North Pacific Ocean for the month of January, 1894. From a circular relating to this new publication, issued by Commander C. D. Sigsbee, U. S. N. Hydrographer, the following is taken : —

"This advance Pilot Chart of the North Pacific Ocean for January, 1894, has been prepared from the most reliable data at present available. Its purpose is to illustrate the character of the monthly publication which has been planned by the Hydrographic Office, for the benefit of the maritime public of the Pacific coast. The Secretary of the Navy has submitted, in his estimates of appropriations required for the service of the fiscal year ending June 30, 1895, an item of $10,000 for the publication of this chart. If Congress should grant this sum, it is proposed to issue, on the first day of each month, an edition of the chart showing graphically such information of timely interest and warning to mariners as can be collected from the reports of incoming navigators. It will represent, for the succeeding month, by deduction from the series of observations that have been for many years collecting at the Navy Department in Washington, the winds and currents to be expected, the regions of prevailing fog and rain, the normal states of the barometer and thermometer, the feeding grounds of whales and seals, and the most advantageous routes to be followed by sail and by steam.

"The support and co-operation of mariners and of all others interested in shortening the duration of voyages of commerce, in enhancing the safety of navigation, and in improving our knowledge of the winds, currents, and storms of the Pacific, are asked in this undertaking; and they are invited to state their opinions as to what matters of practical value should appear on the chart.

"The Hydrographic Office has access to the great libraries and repositories of information that the mariner has not time nor opportunity to consult. By collecting and digesting in this office the nautical information from all quarters in the Pacific, the benefits resulting from the combined experience of the mariners of that ocean are made available for the individual."

It is certainly to be hoped that Congress will grant the sum asked for to cover the cost of publishing this new chart. The admirable work done by our Hydrographic Office in the case of the Pilot Chart of the North Atlantic makes it a foregone conclusion that the chart for the North Pacific would be an equally valuable publication in time, when more data for that ocean have been collected.

Influence of Forests on Climate in Iowa. — In an interesting paper on "Horticulture from a Climatic Stand-point," read by Mr. J. R. Sage, Director of the Iowa Weather Service, before the Iowa Horticultural Society, on Nov. 23, 1893, there are some statements as to the influence of forests on climate which are of value to meteorologists. Referring to the occasional blasts of hot winds from the southwestern plains, which are very injurious to vegetation, being of a high temperature and blowing at the rate of twenty-five to thirty miles an hour, Mr. Sage says: "The best we

can do is to mitigate their severity by conserving moisture, so far as possible, by means of mulch and wind-break. A dense grove at the southwest, located on high ground, will afford a very large measure of protection to the fruit garden and orchard. . . . In my opinion forestry is the chief handmaiden of both horticulture and agriculture. If we had begun early and planted wisely, covering one fifth or even one fourth of our area with nut-bearing or other useful timber, we should now be able to raise much greater crops of corn and fruit on a much lessened acreage. We have now less than 200,000 acres of artificial groves, and about 2,000,000 acres in natural groves. The natural groves serve a good purpose and should be carefully preserved; but these are so located that they afford small protection to the vast regions of upland prairie. We should have at least 5,000,000 acres in planted timber, and our State will never attain its best in fruit and staple crops until we provide these great conservators of moisture and barriers against severe wind storms. With great timber belts judiciously located, and by the construction of artificial ponds and lakes, we may in time be well-nigh exempt from damage by hot winds and drouths, and we may even ward off a large measure of danger from tornadoes. We are compelled to dig or bore deeper wells to strike our constantly receding water level. Our annual rainfall holds up to the average of fifty years, but the water level is being constantly lowered. We must be less prodigal of our moisture, retaining as much of it as possible by artificial forests and ponds. By this means we may make Iowa literally the garden of America, and not merely an immense corn field."

Royal Meteorological Society. — The monthly meeting of this society was held on Wednesday evening, Dec. 20, at the Institution of Civil Engineers, 25 Great George Street, Westminster; Dr. C. Theodore Williams, president, in the chair.

Mr. C. Harding, F. R. Met. Soc., gave an account of the "Great Storm of Nov. 16 to 20, 1893." This storm was the most violent of recent years, and, so far as anemometrical records are concerned, the wind attained a greater velocity than has previously been recorded in the British Islands. The velocity of the wind was 96 miles in the hour from 8.30 to 9.30 P. M., Nov. 16, in the Orkneys, where the hurricane burst with such suddenness that it is described as like the shot of a gun; and the wind afterwards attained the very high rate of 90 miles and upwards, in the hour, for five consecutive hours. At Holyhead the storm was terrific; the anemometer recorded a wind velocity of 89 miles in the hour, and it was 80 miles or above for eleven hours, while the force of a whole gale, 65 miles an hour and upwards, was maintained for 31 hours, and for four and a half days the mean hourly velocity was 54 miles. Many of the gusts were at the rate of 115 miles an hour, and at Fleetwood a squall occurred with the wind at the rate of 120 miles in the hour. The storm was felt over the entire area of the United Kingdom; and the wreck returns show that disasters occurred with almost equal frequency on all coasts. Four weeks after the storm the official records gave the total loss of life on our coasts as 335, while there were 140 vessels which had been abandoned, or had foundered, stranded, or

met with other severe casualty, involving either loss of life, or saving of life by some extraneous assistance. There were six hundred lives saved on our coasts by aid of the Life-boat Institution and other means. The author has tracked the storm from the neighborhood of the Bahamas on Nov. 7, across the Atlantic and over the British Islands to Central Europe on Nov. 20.

The other papers read were, "Rainfall and Evaporation Observations at the Bombay Water Works," by Mr. S. Tomlinson, M. Inst. C. E.; and "On Changes in the Character of Certain Months," by Mr. A. E. Watson, B. A., F. R. Met. Soc.

The Use of Cloud Observations in Weather Prediction. — In a paper entitled, "The Utilization of Cloud Observations in Local and General Weather Predictions," read before the Chicago Congress of Meteorology last August, Mr. Alexander McAdie makes some suggestions regarding a more general use of cloud observations in weather forecasting. Mr. McAdie prepared cloud charts every morning and evening in the Forecast Room of the Weather Bureau at Washington from the data at hand as to cloud movement sent in from the various stations twice a day. He found that it was entirely practicable to construct such cloud charts within the time allotted, and also that these maps can be used to advantage in forecasting. They are particularly useful in fixing the position of the storm centre. Besides the direction of cloud movements, which should be determined instrumentally, the velocities are also needed.

The forecast as to temperature depends somewhat upon the cloudiness, and Mr. McAdie has prepared a set of tables and diagrams which show very clearly that in the United States the greatest amplitude of temperature oscillation is found with the least cloudiness. At Winnemucca, El Paso, and Yuma, for instance, the mean annual cloudiness is three or less on a scale of ten, and the values of the amplitude approach 25° F. At Toledo, Cleveland, and Eastport, on the other hand, the cloudiness is about five, and the mean amplitude about 12° F.

Annual Summary of the New England Weather Service for 1892. — The first Annual Summary of the New England Weather Service appears as Vol. XLI., Part 1, of the Annals of the Astronomical Observatory of Harvard College. Hitherto the annual reports for New England have been published under the title of "Investigations of the New England Meteorological Society," but the Society has no longer any official connection with the weather service.

The number of voluntary observers reporting to the society at the beginning of the year was 162, besides eleven weather bureau stations. During the year the number of the former was increased to 191, and of the latter to twelve. The report contains the usual general account of the weather changes, maximum and minimum temperatures, precipitation, etc., for each month; also small tables showing the general characteristics of the several months of 1892 as compared with the normals for the months in other years, and the departures of monthly temperatures and precipitation from the nor-

mals. The larger tables follow the same plan as heretofore adopted, and the positions of the stations together with the mean annual isotherms are drawn as usual.

Mr. J. Warren Smith is the Director of the Weather Service in New England.

A New Atlas of Scotland. — The Council of the Royal Scottish Geographical Society has undertaken the publication of a new atlas of Scotland, the prospectus of which has recently been issued. The plates will include a general bathy-orographical map, political maps, rainfall and temperature charts and geological maps, besides a large number of geographical maps based on a reduction of the Ordnance Survey. The names of the editors, and the divisions of the subject of which each has charge, are as follows: "Topography," John Bartholomew, F. R. G. S.; "Natural History," J. A. Harvie-Brown, F. Z. S.; "Geology," Sir Archibald Geikie, LL. D., F. R. S., etc.; "Physiography," Prof. James Geikie, LL. D., F. R. S.; "Meteorology," Alex. Buchan, LL. D., F. R. S. E. The various maps in the atlas will be supplemented by explanatory and statistical text, and the plates will measure 16 x 21 in. folio. The price to subscribers not members of the two geographical societies, the Royal and the Royal Scottish, will be two pounds and ten shillings. To non-subscribers any copies that remain will be charged three pounds and three shillings. The atlas will be published by the Edinburgh Geographical Institute, under the direction of Mr. J. G. Bartholomew.

Annual Report of the Meteorological Council to the Royal Society. — The Annual Report of the Meteorological Council to the Royal Society for the year ending March 31, 1893, gives the usual yearly account of the work of the weather service in England. There has been no change in the Council or in the executive officers during the year. Forecasts have been prepared three times a day, at 11 A. M., 3.30 P. M., and 8.30 P. M. The 11 A. M. forecasts are based on the 8 A. M. observations and refer to the probable weather between noon of the day of issue and noon of the following day. These forecasts are publicly exhibited in several places in London, and are supplied to the afternoon editions of the papers. The 3.30 P. M. forecasts are employed for storm warnings only, excepting in the hay harvest season, when they are more extensively used. The 8.30 P. M. forecast is prepared for publication in the morning newspapers.

The total percentage of success obtained in the evening forecasts for the whole of the British Islands was 79, being one per cent less than in the preceding year, and three per cent less than in 1890. Of the storm warnings issued during the year, 90.6% were justified, which is the highest percentage of success on record. The figures for the year 1891 were 86.8%. The anemometer experiments that have been carried on by Mr. Dines for some time past have been concluded for the present. The result of the work has been the construction of a new form of pressure gauge, which is now set up on the roof of the Central Office. This instrument is described by Mr. Dines in Note A of the report. Lieut.-Gen. Strachey has a note on the "Harmonic Analysis of the Hourly Values of Air Temperatures at British

Observatories." The remainder of the report is taken up with the usual information as to stations, publications, etc.

Publication of the Papers read at the Chicago Congress of Meteorology. — The papers read at the Chicago Congress of Meteorology, Climatology, and Terrestrial Magnetism, held last August, are to be published by the United States Weather Bureau in several parts, corresponding to the different sections of the Congress. The first part is nearly ready and the remaining ones are expected to appear shortly.

Weather Bureau Notes. — The Chief of the Weather Bureau has been in correspondence with Sen. Barcena, Director of the Central Meteorological Observatory of Mexico, with reference to the establishment of an exchange of weather telegrams between certain stations of the Mexican Weather Service and the United States Weather Bureau. If the proposed arrangement is made the exchange will probably take place at El Paso.

An announcement of a competitive examination for a professorship in the Weather Bureau was published in the October JOURNAL, pages 290, 291. From the essays submitted under that announcement, the best ten were selected, and the authors were notified to present themselves at the Weather Bureau, in Washington, for a competitive test in forecasting and for further examination as to their knowledge of meteorology. These competitive tests took place in Washington from Jan. 4 to 27. The examination as to a knowledge of meteorology (text-book, "Waldo's Modern Meteorology") occupied ten days. The forecasting test was based on the weather maps for the five years 1888–1893. Each candidate was required to make forecasts for 450 States.

The gentlemen who took part in this competition were: Dr. I. M. Cline, Local Forecast Official, Galveston, Texas; H. J. Cox, New Haven, Conn.; Dr. H. C. Frankenfield, Local Forecast Official, Chicago, Ill.; E. B. Garriott, Washington, D. C.; Dr. M. F. Godfrey, Milwaukee, Wis.; W. H. Hammon, Local Forecast Official, St. Louis, Mo.; Lieut. Everett Hayden, Washington, D. C.; Alexander McAdie, Washington, D. C.; W. L. Moore, Local Forecast Official, Milwaukee, Wis.; Park Morrill, Local Forecast Official, Atlanta, Ga.

CORRESPONDENCE.

THE RECURRENCE OF HURRICANES IN THE SOLAR MAGNETIC 26.68 DAY PERIOD.

Editor of the American Meteorological Journal: —

In the article upon the recurrence of hurricanes in the January number of the JOURNAL, Prof. Bigelow has evidently made use of the table of auroras constructed by myself and widely distributed, in connection with the papers on the Zodiacal Light and Thunderstorms, published by the Rochester (N. Y.) Academy of Science. It is seen from this table that June 12, 1887, was the first day of one of the periods, and that the days of maximum obtained by footing up the numbers of stations reporting auroras are the 3d, 6th, 13th, 17th, 22d, and 26th days, the same as given by Prof. Bigelow. This adoption of my results is very gratifying, and the use that is being made of them in tracing out relations to atmospheric conditions is just what I have been urging by notes and articles and correspondence year after year. I must protest, however, that the shortening of the period from about twenty-seven and one quarter days to less than twenty-seven days is not justified by the evidence from tables of adequate length and covering periods when the conditions were strongly defined. The period certainly is considerably over twenty-seven days, and the adoption of that named by Prof. Bigelow would cause a very decided drift in the groups of larger numbers showing recurrences of the aurora, which now fall in practically the same columns throughout the four years comprised in the specimen extract published. Indeed, I have a table constructed at the twenty-seven day interval years ago and rejected because the period plainly required lengthening. Furthermore, there is a relation to the presence of disturbances at particular solar meridians that requires to be brought out in order to a complete understanding of the principles involved. The evidence is conclusive that eruptive activities thus localized upon particular parts of the sun are the source of the electro-magnetic inductive effects concerned, and that there is such a definite arrangement of lines of force radiating from such electrified portions of the sun's surroundings that the terrestrial magnetic effect can only be felt periodically at the synodic rotation period of the sun. It is of very great interest in this connection to note the evidence that has been adduced in "Nature" (for Nov. 2, page 92, etc.), from the magnetic records at Kew and Greenwich that there were practically no magnetic perturbations at the time of the luminous solar outburst observed by Carrington Sept. 1, 1859, and that the great magnetic storm did not begin until fifteen hours later.

The table of auroras shows that there was a recurrence of this storm at the usual twenty-seven and one quarter day interval, which certainly could

not have happened if it had been due to the merely fortuitous solar outburst whose description has become classic but utterly misleading. Other instances have been noted in addition which likewise show that violence of explosiveness of solar eruptions is not the cause of terrestrial magnetic effects save only when they occur in the proper location. These limitations, constituting the natural history of the phenomena in question, must be understood in detail or there can be no assured progress. The masses of material showing all this and much more that are in my possession and that have been arranged for purposes of personal study are very large, and increasing rapidly in connection with the system of concerted observation of the aurora now in use in co-operation with the expedition of Mr. Peary. Thus far such publication only has been made as will let it be known what sort of work is being done. Enough has been learned, however, to make it certain that this is a rich field as yet almost utterly unworked.

M. A. VEEDER.

LYONS, N. Y., Jan. 2, 1894.

WEATHER MAP DATA AT A HEIGHT OF FIVE THOUSAND FEET.

Editor of the American Meteorological Journal: —

It is clear that light meteorological instruments can be raised to a height of five thousand feet by means of improved tailless Malay kites. On Nov. 7, 1893, a small Malay kite, the string holding which was supported by eight other kites fastened below it, subtended angles of 35° and 66° with a ground line measured on the map of 5,500 feet. The altitude of this top kite was therefore 5,460 feet. At the surface of the earth the total strain of the nine kites at no time exceeded eighteen pounds. The wind velocity at New York, at the top of the Equitable Building, about two hundred and fifty feet above sea level, nine miles distant, was from eight to twelve miles an hour.

An aneroid barometer, a U. Hicks thermometer, and an anemometer, all self-recording, can be so made that their combined weight shall not exceed one pound. The direction of the wind is shown by the kites themselves. I saw in New York an anemometer about three inches in diameter, registering feet, which could be made self-recording by the addition of another registering needle. The small watch case aneroid could push backward a delicate needle and leave it there when the barometer rose with the descent of the kites.

It is yet too early to experiment with instruments in the air. The difficult art of tandem kite-flying in calms and in high winds remains to be perfected, but with proper preparations the day before, an altitude of five thousand feet can be made and the kites all wound in by 6 P. M., without assistance, and in winds of from five to twenty miles an hour.

WILLIAM A. EDDY.

BAYONNE, N. J., Jan. 2, 1894.

BIBLIOGRAPHICAL NOTES.

A NEW TEXT-BOOK OF METEOROLOGY BY H. N. DICKSON, F. R. S. E.

H. N. DICKSON, F. R. S. E., F. R. MET. SOC. *Meteorology. The Elements of Weather and Climate.* Crown 8vo., London, Methuen & Co., 1893. Pages 192. Illustrated. Price, 2/6.

A new text-book of meteorology comes to us from the pen of Mr. H. N. Dickson, whose name is already known to the readers of this JOURNAL as a writer on meteorological and kindred subjects. The volume appears in the "University Extension Series," published by Messrs. Methuen & Co., of London, a series which includes books on historical, literary, and scientific subjects. The object of this collection is to present the different subjects treated in it in a way at once popular and scholarly, in the spirit of the University Extension Movement.

Mr. Dickson's plan is, as he says in his preface, to utilize the common knowledge which most persons possess regarding the general nature of the phenomena which they have to consider in meteorology, to show how to eliminate the errors of this common knowledge, and to arrange it in scientific order. The book is divided into eight chapters. Chapter I. deals with Fundamental Facts and takes up various well-known weather proverbs and prognostics, explaining their meaning and illustrating them by reference to actual examples of different kinds of weather. The general characteristics of a cyclonic system are also brought out. In the second chapter, Fundamental Principles are dealt with, and under this heading the composition, characteristics, and properties of the atmosphere, variations of temperature and pressure, and the deflective effect of the earth's rotation are considered. The third and fourth chapters are entitled, respectively, Cyclones and Anticyclones and other Forms of Pressure Areas. They include a consideration of the forms, characteristics, and relation of these areas, together with the subjects of squalls and tornadoes. Chapter V., on Weather Forecasting, gives some facts as to the methods of forecasting from synoptic charts, storm warnings, and forecasting for solitary observers. The longest chapter is the sixth, on Meteorological Instruments and Observations. The Elements of Climate and The Application of Meteorology to Agriculture are the subjects of the last two chapters in the book.

We are glad to note the appearance of Mr. Dickson's book at the present time. Meteorology is rapidly becoming a subject of general study, and in order to bring it up to the level on which it belongs, text-books which are intelligible to the average reader, and which encourage him to pursue the subject further, are necessary. We think, therefore, that Mr. Dickson's plan of beginning his book with a consideration of some familiar weather proverbs, and of the basis on which they rest, is a good one in many

respects, although it may seem at first thought a somewhat undignified introduction. It is, of course, impossible to treat the subject of meteorology at all thoroughly in so short a space as that allotted to our author in this small volume, and the selection of the best and most useful matters for consideration in such a book is no easy task. Still, we think Mr. Dickson has made a judicious selection as a whole.

There are several matters which we feel disposed to criticise. The great failing of the book is its lack of system. There seems to be no definite plan of treatment, and there is no mention of the wonderful correlation of the various phenomena with one another, which is a most desirable aspect of the subject to present to a beginner, and is the one which makes the whole study of meteorology so fascinating to all who pursue it. As one instance of what we consider a lack of system, we may mention that foehn winds, "derechos," and tornadoes are treated in the chapter on Anticyclones and other Forms of Pressure Areas. Under the heading of tornadoes, dust-storms and waterspouts are considered, as well as tornadoes, and the statement is made in regard to "these whirlwinds" that "it is obvious that the rotation cannot be due to the motion of the earth, and it is probably caused by accidental or local deflection of the air in its movement towards the centre." The small dust-whirls of the desert, as is well known, whirl either from left to right or from right to left, and this whirling depends on the fact that the inflowing currents of air are not all moving in straight lines towards the centre of ascending air. A whirl is thus set up which may rotate either way. In a tornado, however, the whirl is from right to left in this hemisphere, with very few exceptions, the rotation in this case being the same as that of the parent cyclone in connection with which the tornado occurs. The direction of rotation in the tornado is due to the deflective effect of the earth's rotation. We could have wished that Mr. Dickson had given more consideration to such matters as thunderstorms, land and sea breezes, etc., which are only mentioned incidentally, and which are distinctly popular meteorological phenomena.

In spite of its several drawbacks, Mr. Dickson's book is a useful one in its way. It is the first text-book of meteorology written by an Englishman in the spirit of the recent advances of the science. The author has evidently read up his subject well. The low price of the volume, two shillings and sixpence, should ensure it a ready sale.

SNOW CRYSTALS.

HELLMANN, G. *Schneekrystalle. Mit* 11 *Abbildungen im Text und* 8 *Tafeln Schneefiguren in Heliogravure und Lichtdruck nach mikrophotographischen Aufnahmen von Dr. med. R. Neuhauss in Berlin.* Large 8vo. Berlin. Rudolph Mueckenberger, 1893. Pages, 66. Price, 6 marks.

One of the most attractive books that we have seen in any subject is Dr. Hellmann's recent publication entitled "Schneekrystalle." Bound in light gray, with silver lettering, and illustrated with several beautiful photogra-

vure and heliotype plates of snow crystals, it is a book which should find its way into the libraries, not only of meteorologists, but of all persons in any way interested in science. It is, of course, of special value to meteorologists, but mineralogists and chemists, as well as the public generally, will find it well worth reading, and its plates well worth examination.

The difficulty, if not the impossibility, of reproducing the beautiful forms of snow crystals by drawings, led Dr. Hellmann to secure the co-operation of Dr. Neuhauss, an expert photographer, who, with the help of the microscope, has now made it possible to publish in this book the first microphotographs of snow crystals ever printed. To Dr. Hellmann meteorologists are therefore primarily indebted for giving them the first accurate and adequate illustrations of these beautiful snow forms.

The first part of the book is occupied with a review of the most important publications on snow forms from the time of Albertus Magnus, who probably first called attention to the star-shaped forms of snow-flakes, to that of James Glaisher, the principal illustrations given by these old writers being reproduced. Olaus Magnus, Archbishop of Upsala, gave the first views of snow forms in his book "Historia de Gentibus septentrionalibus," published in 1555. He even devoted a whole chapter to the subject under the heading *de variis figuris nivium*. It was Olaus Magnus who first noted the variety of the snow forms, and who gave illustrations of them, but he overlooked the hexagonal form entirely, Kepler, in 1611, having first brought out this point. A curious theory as to the origin of snow was held by Fabri de Peirisc in 1623, who thought that it grew from seeds in the same way that plants do. James Glaisher, in 1855, published the last large collection of snow figures, several of which Dr. Hellmann has reproduced in the present work.

In his second division the author deals with the morphology of snow crystals, basing his statements on the plates reproduced in the book, and on microscopic examination of snow crystals. Of nearly sixty figures of snow forms only four were found to be perfectly regular. The irregularities which usually prevail are ascribed to the movement of the air in the regions in which the snow-flakes are formed, thus preventing their symmetrical crystallization, or to the damage that the flakes may receive in falling to the earth, by contact with other flakes. A careful consideration of the outer shape and of the inner structure of the various snow forms follows, illustrated by constant reference to the photographs, so that every point is made clear. Some interesting measurements of the flakes show that the size of the crystals decreases with increasing cold, the explanation being that as the temperature diminishes the amount of water vapor also decreases, and there is found to be about the same relation between the decrease of water vapor and the decrease of temperature as there is between the size of the snow crystals and the decrease of temperature. The table showing this relationship is as follows : —

Temp.	Mean Diam. of Snow Crystals.	No. of Cases.
—6° C.	3.4 mm.	10
—8° C.	2.2 mm.	6
—12° C.	1.2	6

A cubic meter of saturated air contains, at the temperatures of —6°, —8°, and — 12° C., the following number of grams of water vapor: 3.2, 2.7, 2.0. It will be remembered in this connection that the snow-flakes of the polar regions have often been described as being very small. Indeed, the temperature at which they form has an important influence on the shape of the snow crystals, as well as on their size, the star-shaped forms decreasing in number with decrease of temperature.

Dr. Hellmann presents a classification of snow forms, based on a crystallographic basis, which seems a very systematic and useful one. The two chief divisions in this classification are: First, tabular snow crystals, *i. e.*, those whose main vertical axis is very short compared with the length of the secondary lateral axes, such as the star-shaped forms, plates, and combinations of the two, and second, snow crystals which are columnar in form, *i. e.*, which are fairly evenly developed in the direction of each axis, such as prisms and pyramids. Most snow crystals, according to Dr. Hellmann about eighty per cent, belong to the first class.

The last section of the book is devoted to a consideration of the origin of snow-flakes. They are now practically universally regarded as being formed directly from atmospheric water vapor, without first going through the liquid state. The crystals seem to begin as a microscopically small nucleus of snow, such nuclei being quite frequently found in the upper atmospheric strata and in the polar regions. Around these nuclei the snow crystals are gradually formed, as the former fall to the earth. Such a theory would account for the fact that the polar snow-flakes are very small, their place of origin being so near the earth that there is no opportunity for much development in the way of additional crystallization. There remains still a wide field for research in regard to the causes of the hexagonal crystals and the dependence of the different shapes on temperature.

Dr. Hellmann has certainly given us a most interesting and valuable book, and we most heartily recommend it to the readers of this JOURNAL. Besides the several points already alluded to, the book contains a valuable bibliography, enriched with notes and extracts from the several works referred to in the text.

NEW SOUTH WALES RAIN REPORT FOR 1892.

H. C. RUSSELL, F. R. S. *Results of Rain, River, and Evaporation Experiments made in New South Wales during* 1892. 8vo. Sydney, 1893. Pages XL., 163. 4 plates and diagrams.

The Annual Rain Report for New South Wales for the year 1892 has recently come to hand, and presents a valuable accumulation of rainfall and other observations, together with some interesting maps. Mr. Russell, as Government Astronomer, has been very active in promoting interest in meteorology in New South Wales, as his yearly volumes on "Rainfall and Meteorological Observations," as well as his frequent papers on meteorological subjects, have clearly shown.

The present report contains, besides the usual data, a table of average

rainfall of Australia which is of interest, although of no permanent value, as the figures will undoubtedly have to be changed as the data become more numerous. The table is as follows: —

Authority.	Mean Rainfall.— Inches.
Western Australia, published reports	23.37
South Australia (Sir Charles Todd, climate of South Australia),	21.29
Victoria (the Government Astronomer)	31.65
New South Wales (Annual Rainfall Report)	24.71
Queensland (Annual Report, New South Wales, 1886) .	27.53
Interior of Australia, estimated	10.00

When these amounts of rainfall are weighted in proportion to the area of each colony, the average annual value of the rainfall for the whole of the main land of Australia is found to be 21.15 inches. This is, however, but a rough estimate, as so large a part of Australia is still unknown. Another table gives the average vertical decrease of temperature in New South Wales as 1° F. in 377 feet.

The most noteworthy matter in the report is, to our mind, the new rainfall map of New South Wales, which shows the rainfall of the colony in a very striking way. It shows, for each square degree, the value, in inches, of the mean rainfall over that area, printed in large red figures. Under the figures of the mean rainfall are smaller ones giving the number of years over which the means are taken, and a third set of small figures gives the number of stations used in determining the rainfall. The map is on a scale of thirty-two miles to an inch. It was designed to meet the need of those engaged in pastoral and agricultural pursuits, and is certainly well adapted for the use of such persons, who cannot be expected to read an ordinary shaded rainfall chart with any facility. We are sure that this striking manner of presenting the facts of rainfall will be thoroughly appreciated by the class for whom it was prepared, but the chart is not without considerable value to the more advanced student of meteorology. The distribution of the heaviest rainfall on the eastern coast and the marked decrease inland are very plainly shown. The driest part of the colony is seen to have a rainfall of nine and one half inches. The map is a very effective one for use in the class-room, and we shall ourselves hereafter use it in teaching, together with the old style of rainfall map, also prepared by Mr. Russell, which we have heretofore used, which shows the rainfall by circles whose diameter is proportionate to the amount of precipitation. The latter chart is also a very striking one, and although they are perhaps not so artistic as the ordinary shaded chart, these two maps are certainly most effective in teaching.

New South Wales is to be congratulated on having the services of so energetic a worker in meteorology as its present Government Astronomer.

CLIMATIC CHARTS OF MARYLAND.

In the December number of this JOURNAL we had occasion to note the valuable work done by the Maryland State Weather Service in publishing in its Monthly Bulletin various articles of more than usual interest and importance. Since writing that review we have received two additional publications from Maryland which are notable contributions to the climatology of our country. The first is the First Biennial Report of the Maryland State Weather Service for the years 1892 and 1893, and is entitled, "The Climatology and Physical Features of Maryland." It was prepared under the direction of Dr. William B. Clark, the director of the Service.

The Maryland State Weather Service was organized May 1, 1891, under the joint auspices of Johns Hopkins University, the Maryland Agricultural College, and the United States Weather Bureau. This arrangement has proved to be a very happy one, and the advantage of a close connection of the Weather Service with the University and the Agricultural College has been already seen in the work done by the Service since its beginning. A somewhat similar arrangement was for several years made in New England, where the New England Meteorological Society had the advantage of the directorship of Prof. W. M. Davis, professor of physical geography in Harvard University, although the University had no connection with the Society beyond contributing towards the publication of its observations and investigations in the Annals of the Astronomical Observatory of Harvard College. On April 7, 1892, the bill to establish and make an appropriation for the maintenance of the Maryland Weather Service was approved by the Governor.

The work done in Maryland has been of the same general character as that done in the other States. There have been in all two hundred and twelve observers connected with the Service during the past two years. Weekly weather crop bulletins have been issued during the growing and harvesting season, and monthly bulletins have been published throughout the year. We have already had occasion to call attention to the high character of the articles contained in these monthly bulletins in the review referred to above. The present report is a general review of the climate of Maryland, so far as conclusions can at present be drawn from the data at hand. It is illustrated by maps of precipitation and temperature distribution, tables and diagrams. The basis of the chapters on the Physical Features of Maryland was a series of articles written for the Maryland World's Fair book by Profs. Wm. Hand Browne, Geo. H. Williams, Milton Whitney, and William B. Clark. These several chapters deal with the topography, geology, soils, and climate, and each subject is presented in the clear and concise manner which has been characteristic of the previous publications of the Service. The general question of the relation of the topography and the climate was briefly discussed in a paper prepared by Dr. Clark for the meeting of the Geological Society of America, held in Boston, Dec. 26-28, 1893, and printed in the February number of this JOURNAL. It is therefore

unnecessary for us to review this subject here. In addition to these chapters the report contains a Monthly Summary of the Weather for 1892 and 1893, the Weekly Crop Bulletins, the Monthly Summary of Reports, and Tables of Daily Precipitation.

The second publication referred to is a set of "Climatic Charts of Maryland, including Delaware and the District of Columbia, together with a Map showing the Distribution of the Geological and Soil Formations." These charts are on a scale of eight miles to an inch, are ten in number, and measure eighteen by thirty-three inches. They are accompanied by three pages of explanatory text, the same as that in the Biennial Report, concerning the topography, climate, geology, and soils.

These charts are certainly the most beautiful of the kind that we have seen, and reflect great credit on the State of Maryland and on the State Weather Service that has prepared them. They show the average spring, summer, autumn, winter, and annual precipitation and temperature. The charts themselves are beautifully drawn and colored, and are fine examples of cartographic work, but we cannot help questioning the accuracy of some of the isotherms, although the data at hand are of course insufficient to allow of exact drawing. We can find no statement as to the number of years during which the records that are used on these charts have been kept, nor of the probable reliability of these records, which seems to us a serious omission.

We understand that only one hundred sets of this valuable series of charts have been published. They should be extensively distributed in the schools of Maryland, and we hope that the State Weather Service will be able to print a sufficient number of additional copies to send one to each school. The charts will undoubtedly need extended revision as the data become more numerous, and we feel sure that when the time comes for such a revision the Maryland Service will give us one. We hope the other State Services will, so far as possible, follow the lead of Maryland in this matter of publishing climatic charts.

It is worthy of note in connection with the work done by the Maryland Service that the New Jersey Weather Service also prepared a somewhat similar set of climatic charts for the World's Fair. These charts were five in number, measured twenty-four by thirty-six inches, and were drawn by hand on State maps furnished by the State Geologist. The charts were prepared by Mr. E. W. McGann, the director of the New Jersey Weather Service, and show the seasonal and annual climatic conditions of the State for the year 1892. They were not intended for general distribution, it being the intention of the director to delay such a publication until a ten-year record can be obtained from at least one station in each county. The charts were accompanied by a hypsometric map, showing the geology of the State.

TITLES OF RECENT PUBLICATIONS,

FURNISHED BY MR. OLIVER L. FASSIG, LIBRARIAN, U. S. WEATHER BUREAU, WASHINGTON, D. C.

(An asterisk [*] indicates that the publication thus designated has been received by the Editor of this JOURNAL.)

BENN, T. G. *Observations in meteorology; being the result of a meteorological register kept for ten years* (1883–1892), *at Newton Reigny, Cumberland.* 8vo. Penrith, 1893. 47 pp.

CAIRE. L'OBSERVATOIRE KHÉDIVIAL. *Résumé mensuel des observations météorologiques faites à l'Observatoire Khédivial du Caire, avril, mai, juin,* 1893. 4to. Le Caire, 1893.

CHISTONI, CIRO. *Sulla misura del coefficiente di temperatura dei magneti col magnetometro dei Seni.* Publ. R. Osserv. di Modena. N. 4. 4to. Modena, 1893. 33 pp.

CHISTONI, CIRO. *Sulla determinazione del coefficiente d'induzione dei magneti col metodo di Lamont.* Publ. R. Osserv. di Modena. N. 3. 4to. Modena, 1893. 22 pp.

CHISTONI, CIRO. *Tavole per dedurre il valore dell'umidità assoluta conoscendo l'umidità relativa e la temperatura dell'atmosfera.* Publ. R. Osserv. di Modena. N. 2. 4to. Modena, 1893. 15 pp.

*HINRICHS, GUSTAVUS. *Rainfall laws, deduced from twenty years' observation.* U. S. Department of Agriculture, Weather Bureau. 8vo. Wash., D. C., 1893. 94 pp.

HOLLAND. KON. NEDERL. METEOROL. INSTITUUT. *Nederlandsch meteorologisch Jaarboek voor* 1892. 44. *Jaargang.* (*Appendix-Historisch overzicht van de aardmagnetische waarnemingen in Nederland door Dr. W. Van Bemmelen*) Obl. 8vo. Utrecht, 1893. 328, xl., xxiv., pp.

INDIA. METEOROLOGICAL DEPARTMENT. *Rainfall of India. Second year,* 1892 Published by the various provincial governments and issued under the authority of the Government of India. Fol. Calcutta, 1893.

KAMMERMANN, A. *Résumé météorologique de l'année* 1892 *pour Genève et le Grand Saint-Bernard.* (Extr.: Arch. sci. bibl. univ.) 8vo. Genève, 1893.

*MARYLAND STATE WEATHER SERVICE. *The climatology and physical features of Maryland.* First biennial report of the Maryland State Weather Service for the years 1892 and 1893. 8vo. Balto., 1894 (1893). 140 pp. 6 ch.

*MARYLAND STATE WEATHER SERVICE. *Climatic charts of Maryland including Delaware and the District of Columbia, together with a map showing the distribution of the geological and soil formations.* 18 x 33. in. Balto., 1893. 3 pp. 10 ch. 1 map.

MAURITIUS. ROYAL ALFRED OBSERVATORY. *Annual report of the Director for the year* 1891. 4to. (Port Louis), 1893. 66 pp.

*NEW SOUTH WALES. *Results of rain, river, and evaporation observations made in New South Wales during* 1891. H. C. Russell, Government Astronomer. 8vo. Sydney, 1893. xl., 151 pp. 3 ch.

*NEW SOUTH WALES. *Results of meteorological observations made in New South Wales during* 1890, *under the direction of H. C. Russell, Government Astronomer.* 8vo. Sydney, 1892. xiii., 140 pp. 2 ch.

U. S. WEATHER BUREAU. *Chart showing snow on ground at* 8 P. M., *Monday, Dec.* 4, 1893. (Issued on Tuesday of each week during the winter season.) 18 x 22 in. Wash., 1893.

U. S. WEATHER BUREAU. *Report of the Chief of the Weather Bureau,* 1891 *and* 1892. 4to. Wash., D. C., 1893. 528 pp. 4 pl.

WARSAW. *Spostrzezenia meteorologiczne dokonane w ciagu roku,* 1891. *W. Kivietniewski, Director.* 8vo. Warszawa, 1893.